CROSSBAR DIAL SYSTEM

SECTION III - CROSSBAR SYSTEM CIRCUITS

PART 2 - TERMINATING AND MISCELLANEOUS CIRCUITS

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CHAPTER 21 - SELECTION OF TERMINATING SENDER AND REGISTRATION OF CALLED NUMBER

The process of connecting an incoming trunk upon which a call is waiting, to a terminating or "B" sender is quite similar to that required for connecting a calling subscriber to an originating sender, with the difference that the terminating and "B" sender link must distinguish between incoming trunks requiring terminating senders and those requiring "B" senders and connect a particular incoming trunk to the type of sender it requires. The general arrangement of the terminating sender link start and control circuit, however, is so similar to that for the line link that a complete description of the circuit operation will not be required.

SELECTION OF TERMINATING SENDER

When an interoffice trunk is seized in the originating panel or crossbar office, the (A) relay in the incoming trunk circuit in the terminating crossbar office operates after incoming brush selections closure by the originating sender. The (A) relay grounds a start lead to the associated terminating sender link. The incoming trunks are arranged in groups of ten, each trunk in the group requiring the same type of sender. The start leads for all trunks in a group of ten will operate the same group start (GST) relay in the terminating and "B" sender link start circuit. The start circuit here, as in the line link contains an "A" channel and a "B" channel, the "A" channel causing the home control circuit to be chosen to handle the call and the "B" channel the mate control circuit. The general operation of the start circuit is similar to that discussed for the line link in Chapter 14 and for this reason will be discussed very briefly here. The (GA) relay of the terminating sender link start circuit corresponds to the (HA) relay of the line link. This relay is operated by ground on the "STA" lead through the (GST) relay providing there is an idle sender link and an idle sender available to the trunk group in which the calling trunk appears. This is indicated on Fig. 1, if the "PA" leads for a given group of ten trunks are traced from ground on the off-normal contacts of the primary switch holding magnets of the verticals serving the trunk group, through the (TMB) or (BMB) relay contacts to the (GST) relay contacts. The (TMB) relay normal indicates that there is at least one terminating sender in the group idle. The (GA) relay in turn operates relay (CA) and in turn the frame (FA) relay as in the line link. The operation of relay (FA) operates relays (H) and (HC) which connect the frame to the home control circuit. After this the gate relay is operated in turn operating the trunk group (TG) relay which corresponds to the (HG) relay of the line link.

TRUNK SELECTION

The operated (TG) relay cuts through the start leads of the associated ten trunks to the windings of ten test (T-) relays which correspond to the (LT-) relays used for line test. These relays are arranged in an end relay chain circuit and their operation, followed by the operation of the end relay (TE), results in the selection of the lowest numbered waiting trunk in the group.

SENDER SUB-GROUP TEST

A terminating and "B" sender link frame is served by three sub-groups of ten senders each as previously explained in Chapter 10. The three sub-groups of ten senders are connected to the horizontals of three secondary switches, one switch per sub-group. Each sub-group may contain both terminating and "B" senders or only terminating senders. The incoming trunks appear on horizontals of the primary switches, each trunk being multipled across three primary switch verticals as shown on Fig. 2B of Chapter 10. Each group of ten trunks, therefore, has access to three links to secondary switches, one link to each sub-group of senders. Fig. 1 illustrates a sample arrangement of incoming trunks with respect to the type of sender required. This sketch shows the holding magnets of the verticals on which the three links serving each group are located and indicates the type of sender required by each trunk group.

Before a sender can be chosen for connection to a waiting incoming trunk a test is made to determine whether there is a sender sub-group available with at least two idle senders of the type required and whether there is an idle sender link from the trunk group in which the waiting trunk appears to the sender sub-group having idle senders available. Fig. 1 illustrates the method of making this test. Each sender is provided with a sender busy (SB) relay and in addition, there is a sender group (SG) relay per ten senders. The contacts of the (TSG) relay are connected to the contacts of (SB) relays representing terminating senders and those of the (BSG) relay to (SB) relays of "B" senders. The (TSG) relay is operated by the (TG) relays of incoming trunk groups requiring terminating senders and the (BSG) by those of incoming trunk groups requiring "B" senders.

The operation of an (SG) relay indicates that there are at least two idle senders in the associated sub-group and that there is an idle sender link to that sub-group. The ground for operating an (SG) relay, see Fig. 1, is obtained

through the contacts of unoperated (SB) relays through the (TSG) for terminating senders and the path can now be traced on Fig. 1 through the (TMB) relay and operated (TG) relay through the normal contacts of the holding magnet, representing an idle sender link, through the (TG) relay to the winding of an (SG) relay. This ground path insures that an (SG) relay will not be operated unless at least two senders and the associated sender link of the sub-group are idle.

SENDER SUB-GROUP SELECTION

Assuming that one or more (SG) relays operate on this test, one of the (SG) relays is chosen as discussed in Chapter 14. This results in the operation of a connector (C) relay which cuts through the necessary control leads to the group of senders.

SENDER SELECTION

After the sub-group of senders to be used in establishing the call has been indicated an individual sender is chosen in accordance with the number of the calling trunk in its group of ten. This process is similar to that discussed in Chapter 14 for choosing a district junctor in a group of ten. If the preferred sender is busy the next available sender in the preference chain will be chosen depending upon which (SB) relays of senders in the sub-group are operated. As soon as the sender has been chosen, its associated (S) relay is operated followed by the operation of the corresponding secondary switch select magnet. The sender is notified of its selection by a ground on the "SC" lead, as indicated on Fig. 2. When the holding magnets of the link have been operated, a ground is sent into the sender which in turn operates its associated (SB) relay in the sender link and furnishes a holding ground for the hold magnets.

RECORDING FRAME INDICATION

After a sender has been selected as described above, the number of the sender link frame is recorded in the sender. This information will be given to the terminating marker as an indication of the number of the incoming link frame serving the waiting incoming trunk.

The grounding of the "SC" lead by the terminating sender link circuit operates relay (SC1) as indicated on Fig. 2. Relay (SC1) operates to the "SC" lead on its primary winding and then holds to it by its secondary winding. The primary winding is used for the purpose of checking the battery circuit through the resistance lamp (CO), thus being of great importance at a later stage in the connection.

Relay (RV3) operates over the "F00" or the "F10" lead from the sender link and control circuit after (SC1) and either (F00) or (F10) operates and is held by an off-normal ground after (ON1) operates. The (F10) relay is operated only when the number of the terminating sender link frame is over 9. The operation of the (RV3) relay causes the operation of (RV4) and in turn the (RV5) relay. After the (RV5) and (SC1) relays operate, ground on the "GS" lead operates relay (ON1). When relay (SC1) has operated (SC2) also operates to the "SC" lead and it connects the frame indication leads "F0" to "F9" to the corresponding register switch selecting magnets. One of the selecting magnets operates from ground in the sender link and control circuit in accordance with the units digit of the incoming frame number and it passes the operating ground on to operate relay (SM). The (SM) relay, in operating, causes the (RA) relays and (F) holding magnets to function, recording the frame number in a manner similar to that described for registering frame indication in Chapter 14.

RELEASE OF SENDER LINK AND CONTROL CIRCUIT

As soon as the sleeve cross points are checked for continuity and double connections, the (DC) relay in the sender link grounds the "GS" lead operating the sender (ON1) relay and in turn operating the link (SB) relay as shown on Fig. 2. With relay (SB) of the sender link and control circuit operated, ground is placed on lead "BS" to operate relay (ON2) as shown on Fig. 3. This grounds the "S" lead to hold the sender link holding magnets after its control circuit is released. The operation of relay (ON2) also places ground on lead "RL" to the sender link and control circuit to operate relay (R) which in turn releases the control circuit.

REGISTRATION OF CALLED NUMBER

The terminating sender is now connected to the incoming trunk through the terminating sender link and is ready for registration of the called number. This will be done by a revertive pulsing process similar to that required for incoming and final selections in a panel office.

OPERATION OF (STP) AND (L) RELAYS

When the (ON1) relay operated, (see Fig. 4) the tip lead was closed from the incoming trunk through the (L) relay to battery and the ring lead to ground. The (L) relay may or may not operate at this time. The terminating sender (STP) relay is shunted by ground on the ring from the incoming trunk (D) relay and also through the contacts of the (L1) and (L2) relays. The (STP) relay will not operate to start selections until these grounds have been removed. However, the battery and ground from the (A) relay holds the (STP) relay in the originating sender which operated shortly after the incoming trunk was picked. When relay (SC1) in the terminating sender released indicating that the sender link control has completed its checks and has released, the "CO" lead was grounded operating the (T) relay in the incoming trunk which removes the (A) relay from the trunk and also the ground from the ring conductor. If the (L) relay did not operate before, it will now operate.

As has been shown, relay (SM) operated when a select magnet operated for frame indication,

then closed a circuit to operate relay (L1) which in turn operated relay (L2). With these relays operated, the shorting ground is removed from the (STP) relay in the terminating sender allowing it to also operate in series with the (L) relay and (STP) relay in the originating sender.

With the (STP) relay of the terminating sender operated, relay (GR) operates which grounds the "T" lead, causing the release of the (STP) relays in both the originating and terminating senders, but holding relay (L) operated which in turn holds (L1) and (L2) relays operated. This pulsing or alternate operation and release of the two (STP) relays, continues until the counting relays are satisfied in the originating sender. The operating circuit for relay (L) is then opened indicating the completion of that series of pulses.

In order to extend the life of the contacts of the (STP) relay, the direction of current flow through the contacts is reversed when relay (EF) operates. Relay (EF) operates on all calls from even-numbered incoming frames.

TERMINATING SENDER PULSING RELAY OPERATION

The terminating sender counts the pulses on relays (P1) to (P6) as shown on Fig. 5 actuating them by relays (L3), (L4), and (L5). The periodical operation and release of relay (GR) causes relays (L3), (L4), and (L5) to operate and release in a recurrent cycle of half the frequency, as follows: The operation of relay (GR) on the first or any odd-numbered pulse operates relay (L3); its release permits relay (L5) to operate in series with relay (L3), the operation of relay (GR) on the second or any even-numbered pulse operates relay (L4) in series with the secondary winding of relay (L5), whereupon relay (L3) releases but relay (L5) holds. The release of relay (GR), causes relays (L4) and (L5) to release. Thus, relay (L5) operates at the end of each odd pulse and releases at the end of each even pulse. The ground connection for holding relays (L3) and (L5) in series is furnished by the parallel front contacts of relays (L1) and (L2) so that they will release after the last pulse of each selection.

The operation of relay (L5) on the first pulse causes relay (P1) to operate and lock. The release of relay (L5) on the second pulse causes relay (P2) to operate, lock itself, and unlock relay (P1), which releases. Similarly, the operation or release of relay (L5) on subsequent pulses operates other (P-) relays. The relays left locked up after each pulse, any one of which may be the last pulse of a selection, are as follows:

Pulse	Relays	Pulse	Relays	Pulse	Relays
1	P1	5	P5	9	P3-P6
2	P2	6	P5-P6	10	P4-P6
3	P3	7	P1-P6	11	P4-P6-TT
4	P4	8	P2-P6		

OPERATION OF HOLD MAGNETS

Each time relay (SM) operates, it either operates relay (RA1) and leaves relay (RA2) normal, or it releases relay (RA1) and leaves relay (RA2) operated as shown on Fig. 2. In either case, the effect is to connect the windings of relay (HM) to the winding of the first non-operated hold magnet, causing the same to operate as shown on Fig. 6. Relay (HM), having differential windings does not operate at this time. The hold magnet closes the contacts of the cross points at the level of the operated select magnet, locks up to a front contact of relay (ON1) or (ON2) and by connecting the locking ground to the windings of relay (HM), causes that to operate on its secondary winding. When relay (HM) has operated on one selection and relay (L2) on the next selection, relay (SM) and the operated select magnet release.

Each time relay (SM) releases, it either operates relay (RA2) and leaves relay (RA1) operated, or it releases relay (RA2) and leaves relay (RA1) normal. In either case the effect is to disconnect the windings of relay (HM) from any hold magnet, and relay (HM) releases. This serves to step from one hold magnet to another so that the call is recorded on the incoming brush (IB), incoming group (IG), final brush (FB), final tens (FT) and final units (FU) hold magnets.

When the last selection, final units, has been transmitted from the originating sender to the terminating sender, the former closes the fundamental circuit again through its stepping and overflow relays and awaits a reverse battery pulse to operate both of those relays and then release the stepping relay. Whenever a call is abandoned after an incoming trunk has been seized and before final units selection has been made, the subscriber sender causes the next selection to go to tell tale in order to properly restore the equipment in the terminating office without signaling the called subscriber.

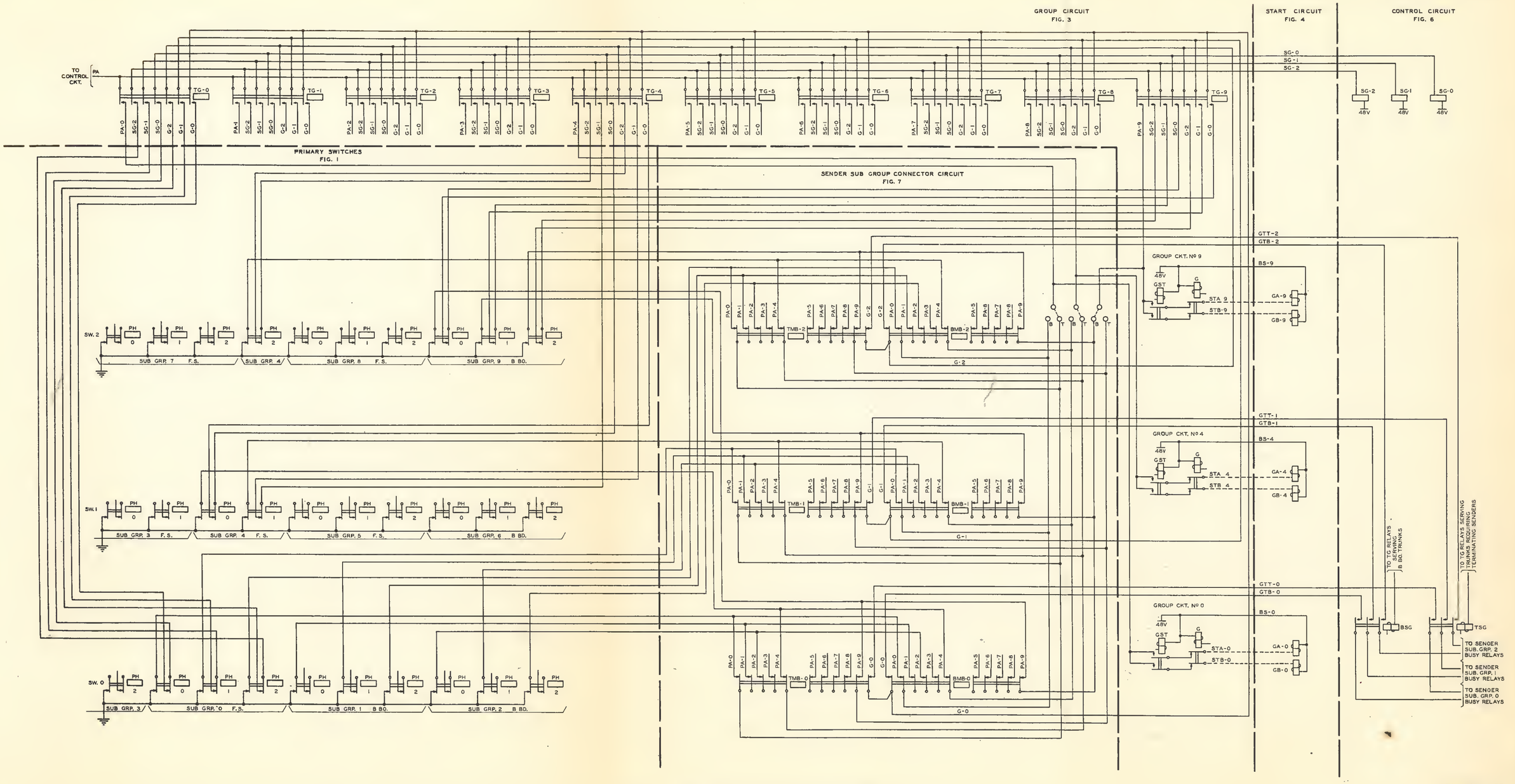


Fig. 1 - Distribution of "PA" and "GT" Leads - Terminating Sender Link Circuit

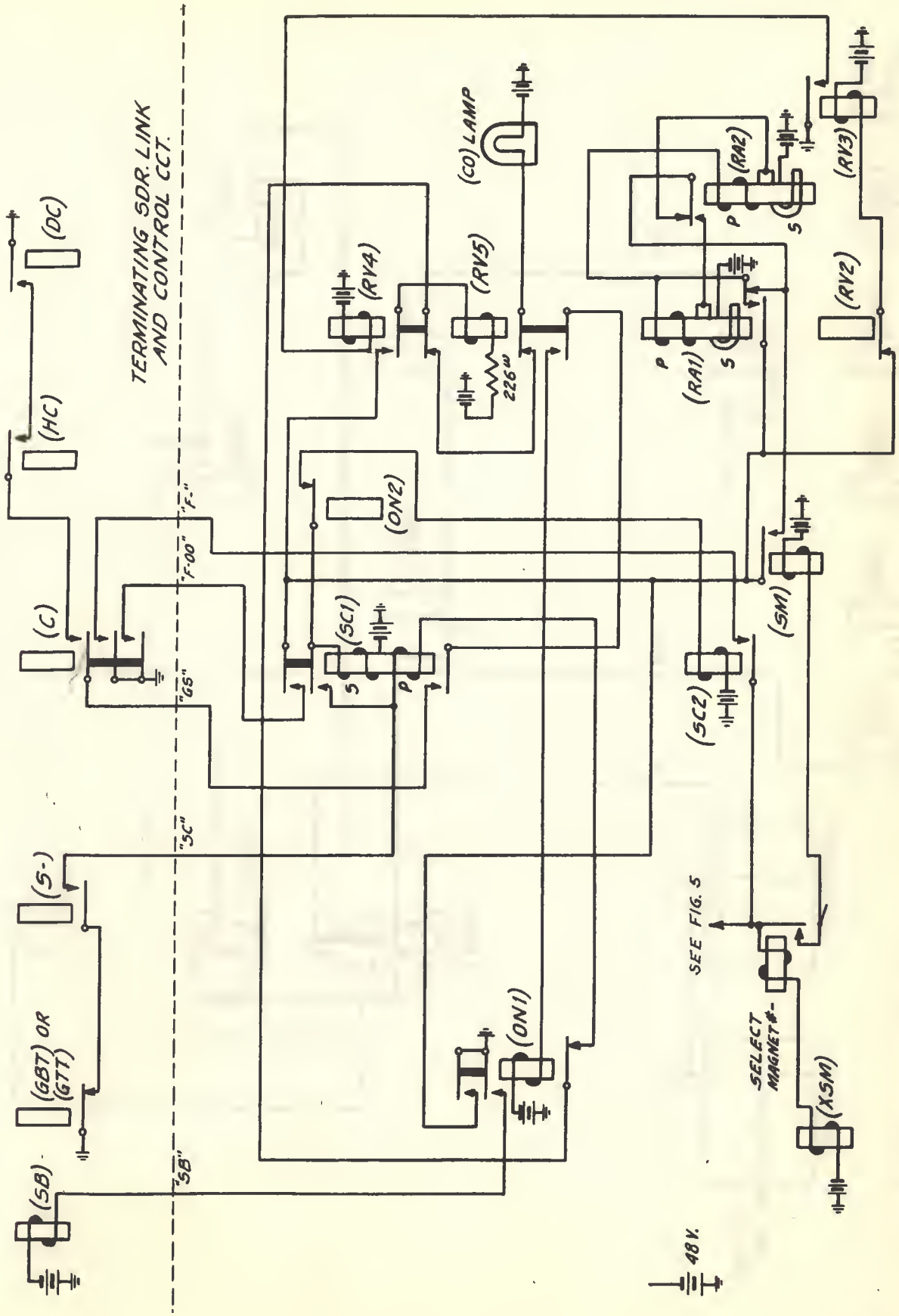


Fig. 2 - Recording Frame Indication

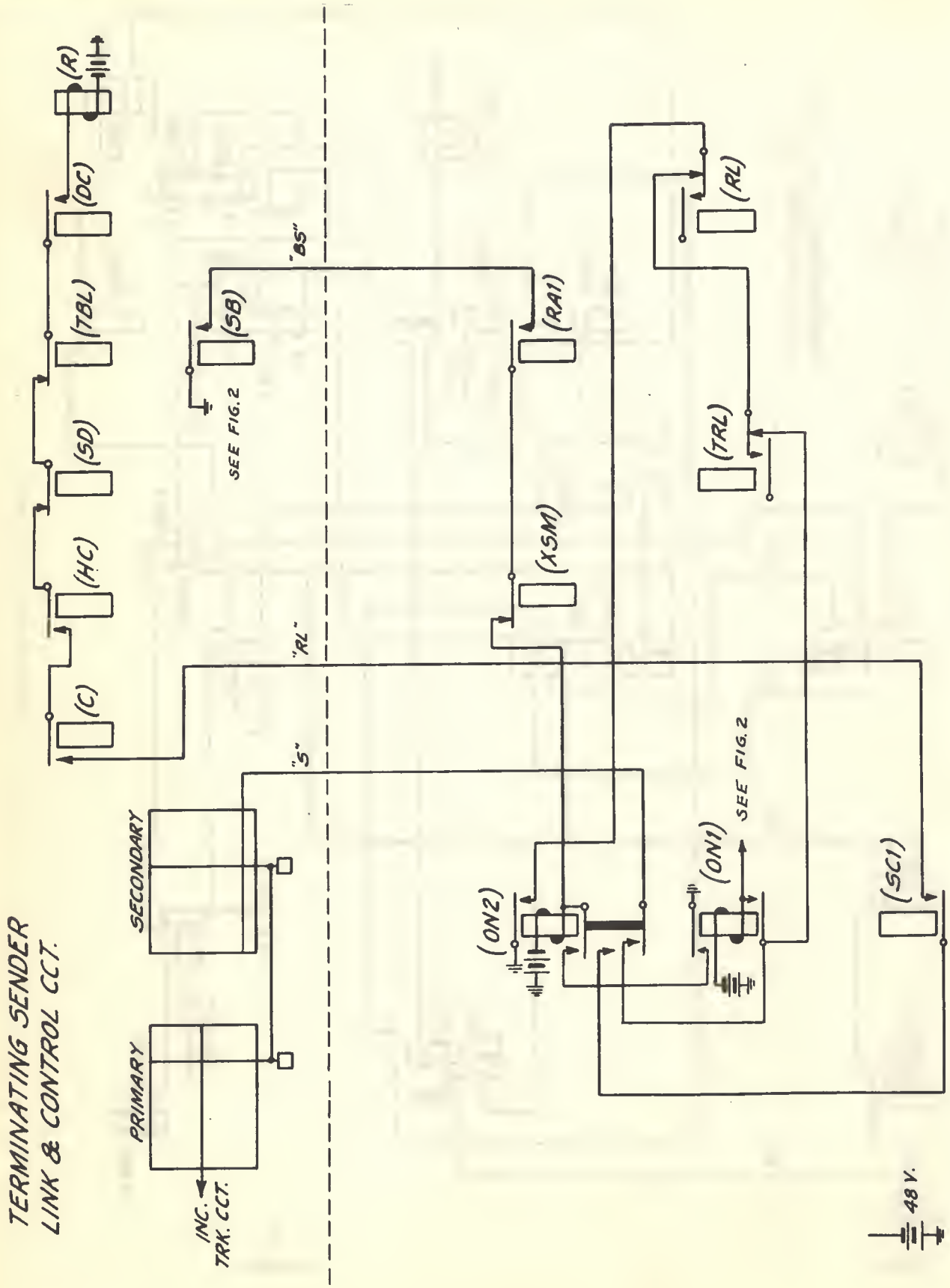


Fig. 3 - Release of Sender Link Control Circuit

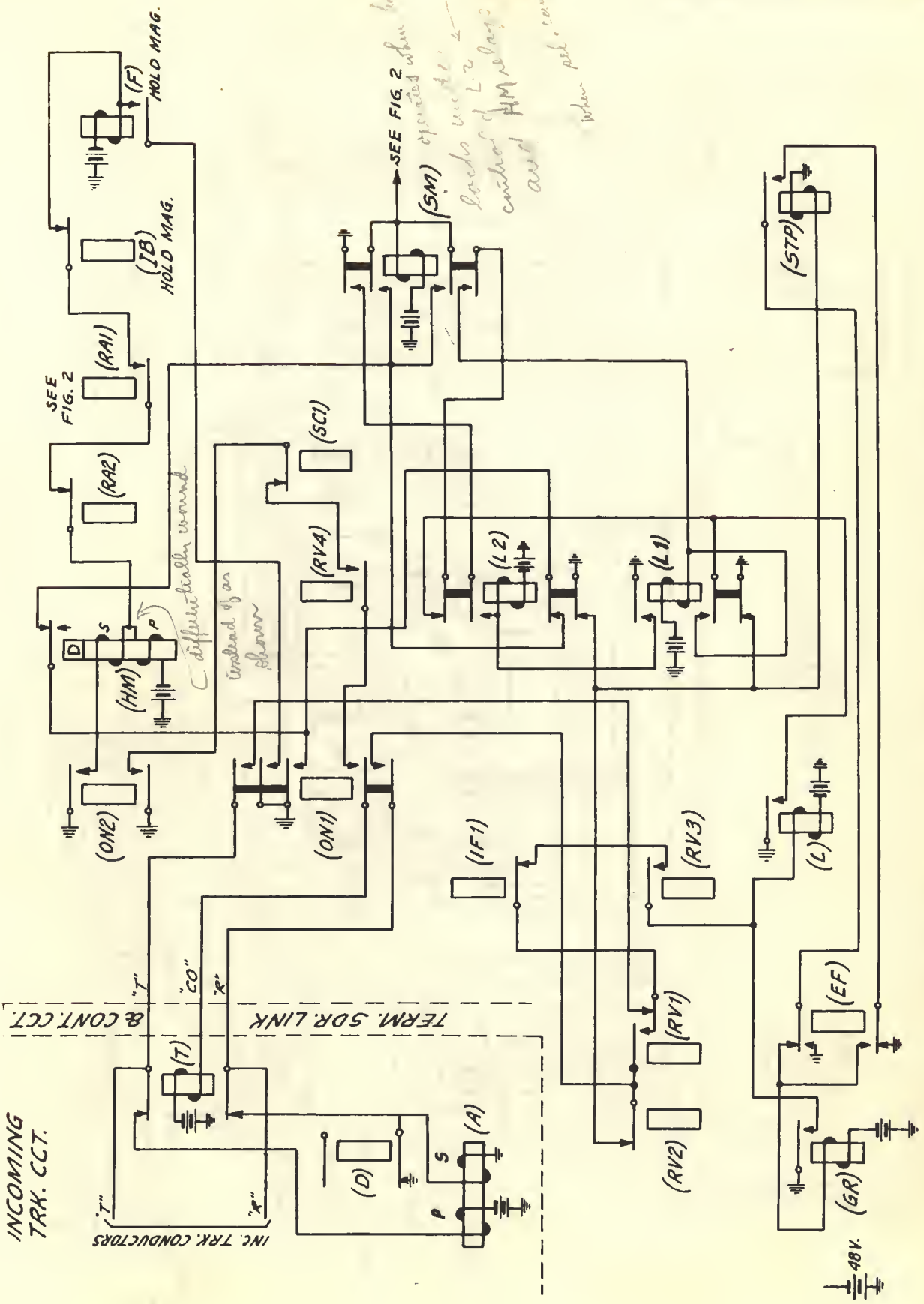


Fig. 4 - Operation of (STP) and (L) Relays and (F) Holding Magnet

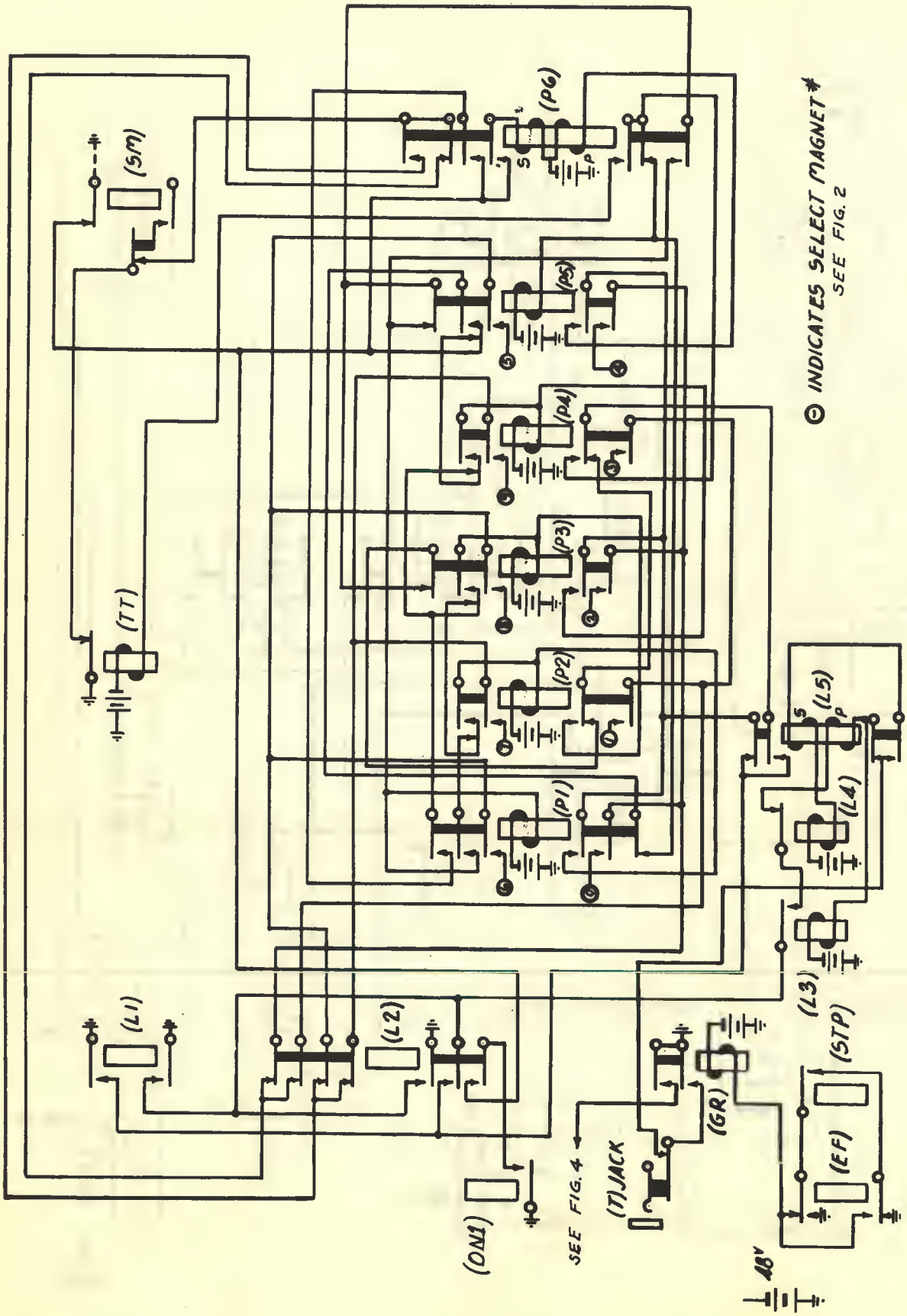


Fig. 5 - Operation of Selecting Magnets

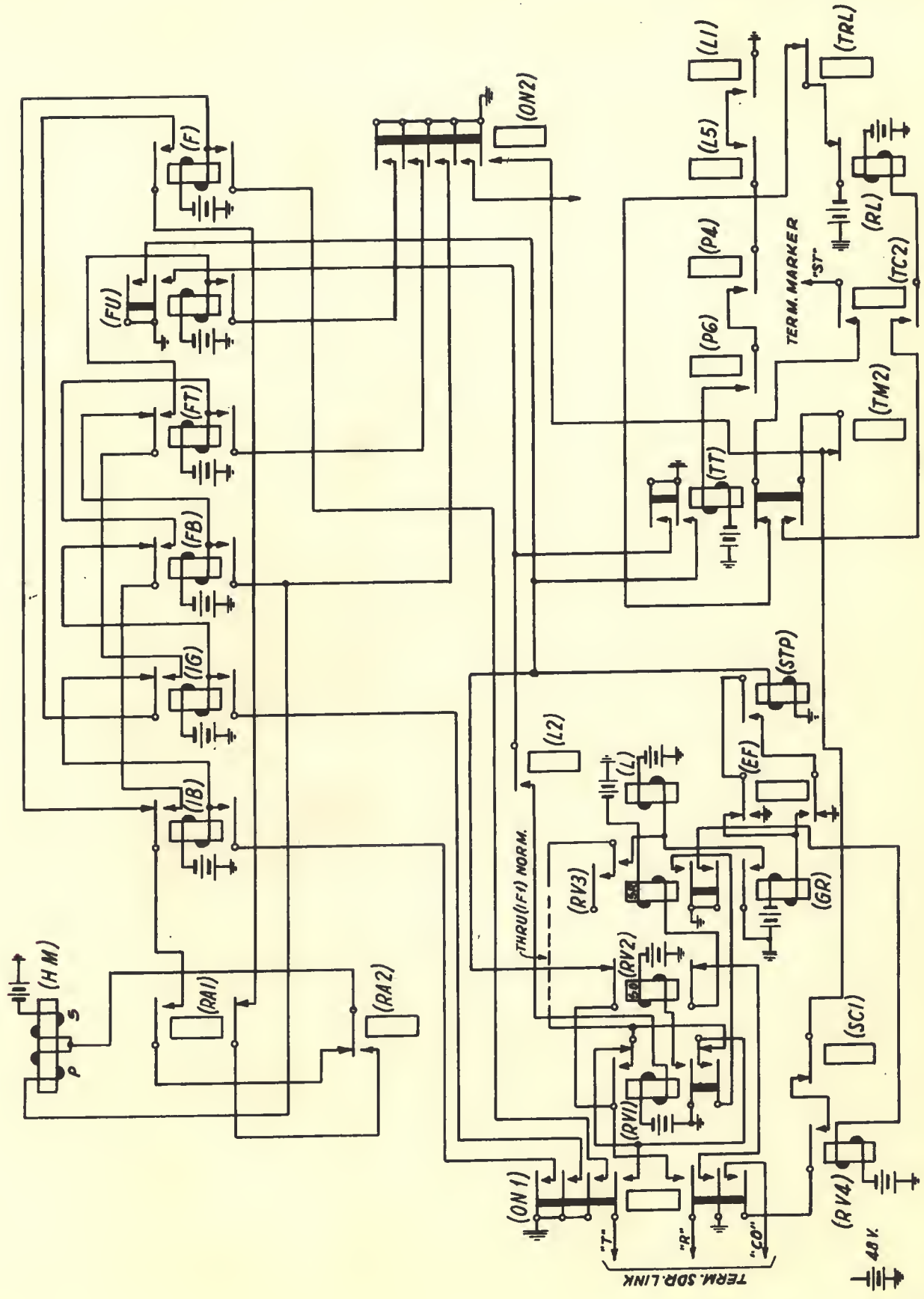


Fig. 6 - Operation of Holding Magnets - Tell Tale Operation

CHAPTER 22 - TERMINATING SENDER - INCOMING ADVANCE - SEIZURE OF TERMINATING MARKER

As pointed out in previous chapters, the originating sender functions as though the call were being completed in a panel office. It is for this reason that the called number is registered in the terminating sender as incoming and final selections instead of as a four-digit number. If the call were actually being completed in a panel office, the incoming selector, as soon as final selections are completed, would send a reverse battery pulse to the originating sender as an indication that it is ready for trunk closure from the district selector. This is, of course, a signal that the originating sender may be dismissed from the call. The present chapter discusses the simulating of "incoming advance" by the terminating sender in the crossbar office.

FUNDAMENTAL CLOSURE

When the units selection has been transferred from the originating sender to the terminating sender the originating sender closes the fundamental circuit again through its stepping and overflow relays and waits for a reverse battery pulse to operate both these relays and then release the stepping relay when the reverse battery pulse is ended. The fundamental circuit at this instant may be traced on Fig. 1. The (L) relay in the terminating sender is connected to the tip of the trunk and ground is connected to the ring of the trunk from the contacts of the (FU) holding magnet.

The above condition results in the operation of the (L) relay in the terminating sender and the (STP) relay in the originating sender; no other action takes place in the originating sender at this time. The operation of the (L) relay operates the (L1) and (L2) relays in the terminating sender. The operation of the (L2) relay operates the (RV1) relay from ground on the off-normal contacts of the (FU) holding magnet. The (RV1) relay transfers the winding of the (L) relay from the tip to the ring of the trunk and in so doing ground is connected to both the tip and the ring of the trunk. This discharges the cable pair in order to prevent the (OFL) relay in the originating sender from operating falsely due to cable surges. The distant stepping relay loses its energy and the (L) relay in the terminating sender is heavily energized.

REVERSE BATTERY

The slow operating relay (RV2) now operates and removes ground from the ring of the trunk. The direction of current is now reversed through the originating sender (STP) and (OF) relays and due to the heavily energized condition of the (L) relay the reversed current is built up suddenly and tends to operate the distant (STP) and (OF) relays simultaneously.

RECORDING REVERSE BATTERY

The operation of the (OF) relay in the originating sender locks and operates the incoming advance (IA) relay. The (IA) relay closes through ground from the operated (STP) relay to operate the (O) relay. The operation of the (RV2) relay in the terminating sender opened the circuit for the slow releasing (RV3) relay. The release of the (RV3) relay opens battery and ground from the trunk, releasing the (STP) in the originating sender. The release of the (STP) permits the (BO) and (FO) relays to operate. The (FO) relay in operating, operates the advance (AV1) relay, An additional make contact is provided on the (IA) and (CR5) relays to operate the (O), (BO), and (FO) if the (STP) relay does not operate. This is to take care of very short reverse battery closures provided by some of the very early panel incoming selectors. Normally, the (CR5) relay is not operated, since on long trunks there is a possibility that the (OF) and (IA) relay could operate before the (STP) relay in which case the (BO) relay would operate, if (CR5) was operated, and open the fundamental circuit too soon and possibly leave the terminating circuit stranded in reverse battery condition.

CLOSING TRANSMISSION CIRCUIT IN DISTRICT JUNCTOR

The (AV1) relay grounds the "TR" lead to the district junctor operating the (T) relay thus connecting the supervisory (S) relay to the tip and ring of the calling line. The operation of the (S) relay, due to the off-hook condition at the calling station, operates the (S1) relay and in turn connects the polarized called supervisory (CS) relay across the tip and ring toward the distant incoming trunk circuit. The (CS) relay does not operate at this time but waits for reverse battery from the incoming trunk as an indication that the called party has answered.

DISMISSING ORIGINATING SENDER

The operation of the (AV1) relay operates the (AV2) relay, in turn releasing the (AV3) which operates the (AV4) relay. The operation of the (AV4) relay disconnects the subscriber sender link and releases the sender as described in Chapter 14. The slow release time of the (AV3) relay is to allow time for the distant (T) relay to operate and also to provide trunk closure on abandoned calls.

DISCHARGE OF TRUNK CAPACITY

The release of the (RV3) relay in the terminating sender ends the reverse battery closure and releases the (RV4) relay. The (RV4) relay is slow releasing to allow time for the (STP) relay to release and the (BO) relay to operate. The release of the (RV4) relay discharges the capacity of the trunk by connecting battery to both the tip and the ring leads, the (RV5) relay being operated. The release of the (RV4) relay also releases the (T) relay in the incoming trunk, preparing the circuit for trunk closure. When the (T) relay releases, direct ground is connected to the ring lead from the (D) relay, shunting the (RV5) relay which disconnects battery from both the tip and ring leads and connects the 8J resistance lamp in parallel with the incoming trunk (T) relay to keep it released if there is a ground from the supervisory relay operated in the incoming trunk when the (D) relay operates. It is necessary to discharge the trunk capacity to avoid falsely registering trunk closure when the originating equipment, especially in a panel office, is slow in providing trunk closure.

SEIZURE OF MARKER CONNECTOR

The terminating sender is now ready to refer the called number to a terminating marker through a terminating marker connector. Before it attempts to seize a marker connector it awaits a signal from the incoming trunk indicating that it has received trunk closure from the district junctor and that the calling subscriber has not abandoned the call. Trunk closure in the district junctor occurs when the (CS) relay is connected across the tip and ring of the trunk.

TRUNK CLOSURE

When the (AV1) relay in the originating sender operated, it operated the (AV2) relay which connects a 500 ohm non-inductive resistance across the tip and ring of the trunk at the originating end, thus providing trunk closure. The (CS) relay and retard coil in the district junctor are also bridged across the trunk by the operation of the (T) relay. The 500 ohm bridge in the sender is necessary for trunk closure on abandoned calls, when the (T) relay is never operated. Trunk closure operates the (A) relay in the incoming trunk. In the meantime, the release of the (RV5) relay closed ground over the "D" lead to operate the (D) relay in the incoming trunk as shown on Fig. 2. The operation of the (A) relay now locks the (D) relay and this ground is extended into the terminating sender operating the polarized trunk closure (TC1) relay. The (TC2) relay connects battery to the "ST" lead to the marker connector circuit.

TELL-TALE ON ABANDONED CALLS

If a call is abandoned before selections are completed, or if a trouble condition in the originating sender prevents its breaking the fundamental circuit when ten pulses have been generated in the terminating sender on any selection, or if a trunk with crossed conductors seizes the sender without being called into service at the originating end, a "tell-tale" condition ensues. This condition is one where the pulses of a selection are allowed to run to eleven, and is so called because a similar condition, when a panel incoming or final selector is involved instead of a crossbar terminating sender, drives the selector elevator to the tell-tale position.

The eleventh pulse will operate relay tell-tale (TT). The (TT) relay locks up and grounds that transfer spring of the (L2) relay and that back contact of the (RV2) relay which in a completed call are grounded by the operation of the (FU) hold magnet, (see Fig. 1). (RV1) relay operates and the succeeding operations are the same as in incoming advance and trunk closure of a completed call, except that the sender is released without calling in a terminating marker.

The (RV4) relay releasing removes ground from the "CO" lead, restoring the incoming trunk (A) relay to its normal connection with the trunk.

The operation of the (TC2) relay cannot call in a marker because a back contact of (TT) relay opens the "ST" lead, (see Fig. 2) but the (TC2) relay closes a circuit through (TT) relay to operate relay (RL) which causes the sender to release.

SEIZURE OF CONNECTOR

The control circuit for each terminating marker connector consists of one sender start (SS) relay for each sender having access to the connector together with several connector alarm (CA-) relays. Battery on the start lead from the terminating sender operates the associated (SS) relay and the (CA1) relay as shown on Fig. 2.

The multicontact relay (S), also associated with the particular terminating sender, will not operate unless the (TR) relay is normal. The (TR) relay operates in case of a trouble release signal from the marker so that on second trial the sender will seize another marker. The (TR) relay is held operated until the sender is dismissed. The operation of the (SS) relay causes the (S) relay to operate. Both the (S) and (SS) relays are held to the "ST" lead of the terminating sender.

SEIZURE OF TERMINATING MARKER

The operation of the sender (S) relay connects the start lead to the (DS) relay of the first idle terminating marker through the connector busy (CB) relay. The (DS) relays are arranged in a chain circuit which extends from a (DS) relay in one connector to the (DS) relays belonging to the same marker in the succeeding or preceding connectors. The first (DS) relay in the chain is in the block of connectors which has the particular marker as first choice and all other connectors are in a fixed order in the chain.

The operation of the (DS) relay operates the terminating marker (TM) connector relay connecting the terminating marker to the connector and hence to the sender since the sender (S) connector relay is operated. The (TM) relay operates

the (CBR-S) relays in the marker which in turn operate the (CB) relay representing that marker in all connectors. The (CB) relay in the connector which has its (TM) relay operated is kept normal by a short-circuit from ground at the (TR) relay.

OPERATION AND LOCKING OF THE (CK4) AND (CK5) RELAYS

Before any information is transmitted from the terminating sender to the terminating marker the integrity of all leads connected between the sender and the marker through the connector is checked.

The (CK6) and (CK7) relays are operated from the connector circuit by the grounded "CKG" lead as indicated on Fig. 3. When the leads are cut through from the sender, the marker receives a record of the four numerical digits and the number of the incoming frame on which the call was received. This information is recorded on the numerical and incoming frame register relays similar to the way information is passed from the originating sender to the originating marker. Reorder is registered on the (RO) relay and second trial on relays (TR1), (TR2), and (TR3).

All the recording relays and relays (RO), (TR1), and (TR2) are operated provided none of their leads are open. Relays (CK1), (CK2), and (CK3) are operated from ground on the corresponding leads, supplied when the (CK6) relay operates. The leads from the sender have either solid ground or ground from one of the check leads "CK1", "CK2", "CK3", or "CK4".

When all the marker recording relays are operated, they close a chain in conjunction with relays (CK1), (CK2), and (CK3) to operate relays (CK4) and (CK5) from ground on relay (F1).

The operation of relays (CK4) and (CK5) breaks the normal operating paths for relays (CK1), (CK2), and (CK3) and also opens the grounding circuit for leads "CK1", "CK2", "CK3", and "CK4" which should release all the recording relays excepting those operated by solid ground in the sender. If any one of the unused receiving leads is falsely grounded, the false ground will back up on lead "CK1", "CK2", "CK3", or "CK4", preventing the (CK1), (CK2), or (CK3) relay from releasing. This would prevent translation from being completed.

The called number and the incoming link frame number are recorded on the (TH), (H), (T), (U), and (F) relays, respectively, at the conclusion of the series of operations discussed above. The recording relays remaining operated will be in accordance with the following tables. The (F) register grounds leads "F1", "F2", "F4", and "F5" according to the incoming frame as follows:

Frame	Leads Grounded	Frame	Leads Grounded
0 or 10	None	5 or 15	F5
1 or 11	F1	6 or 16	F1-F5
2 or 12	F2	7 or 17	F2-F5
3 or 13	F1-F2	8 or 18	F1-F2-F5
4 or 14	F4	9 or 19	F4-F5

If the frame number is 0 to 9 relay (F00) connects lead "F10" to lead "CK4", or if it is 10 to 19 relay (F10) grounds lead "F10".

The (IB) and (IG) registers ground leads "TH1", "TH2", "TH4", and "TH8" according to the thousands digit of the called number as translated from the incoming brush and group selections, as follows:

Thousands	IB	IG	Leads Grounded
0	0	0 or 1	None
1	0	2 or 3	TH1
2	1	0 or 1	TH2
3	1	2 or 3	TH1-TH2
4	2	0 or 1	TH4
5	2	2 or 3	TH1-TH4
6	3	0 or 1	TH2-TH4
7	3	2 or 3	TH1-TH2-TH4
8	4	0 or 1	TH8
9	4	2 or 3	TH1-TH8

The (IG) and (FB) registers ground leads "H1", "H2", "H4", and "H5" according to the hundreds digit of the called number as translated from the incoming group and final brush selections, as follows:

Hundreds	IG	FB	Leads Grounded
0	0 or 2	0	None
1	0 or 2	1	H1
2	0 or 2	2	H2
3	0 or 2	3	H1-H2
4	0 or 2	4	H4
5	1 or 3	0	H5
6	1 or 3	1	H1-H5
7	1 or 3	2	H2-H5
8	1 or 3	3	H1-H2-H5
9	1 or 3	4	H4-H5

The (FT) register grounds leads "T1", "T2", "T4", and "T5", and the (FU) register grounds leads "U1", "U2", "U4", and "U5", according to the tens and units digits, respectively, of the called number, which are the same as the final tens and final units selections, as follows:

Tens or Units	FT	Leads Grounded	FU	Leads Grounded
0	0	None	0	None
1	1	T1	1	U1
2	2	T2	2	U2
3	3	T1-T2	3	U1-U2
4	4	T4	4	U4
5	5	T5	5	U5
6	6	T1-T5	6	U1-U5
7	7	T2-T5	7	U2-U5
8	8	T1-T2-T5	8	U1-U2-U5
9	9	T4-T5	9	U4-U5

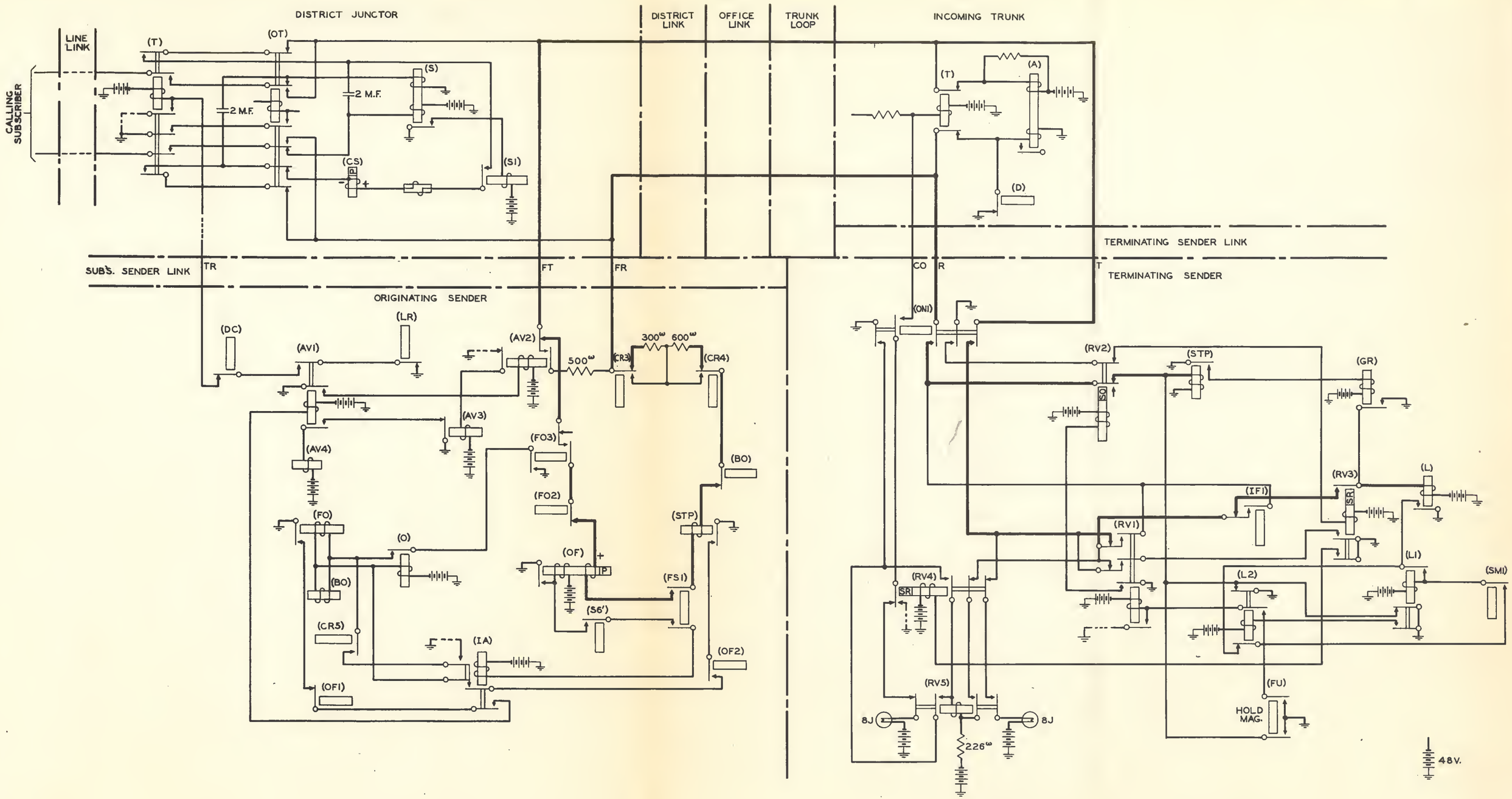


Fig. 1 - Fundamental Circuit

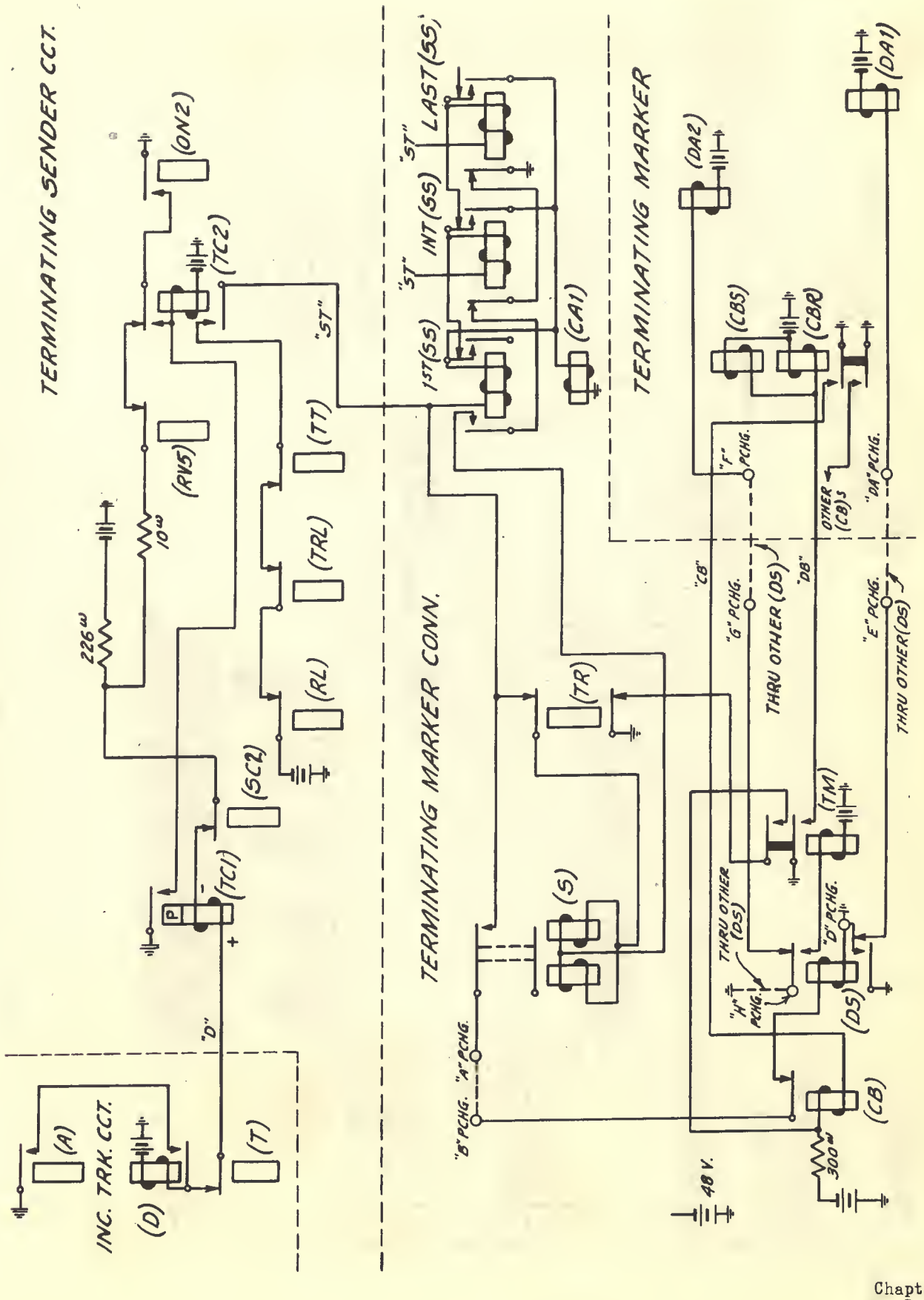


Fig. 2 - Terminating Sender - Seizure of Marker Connector

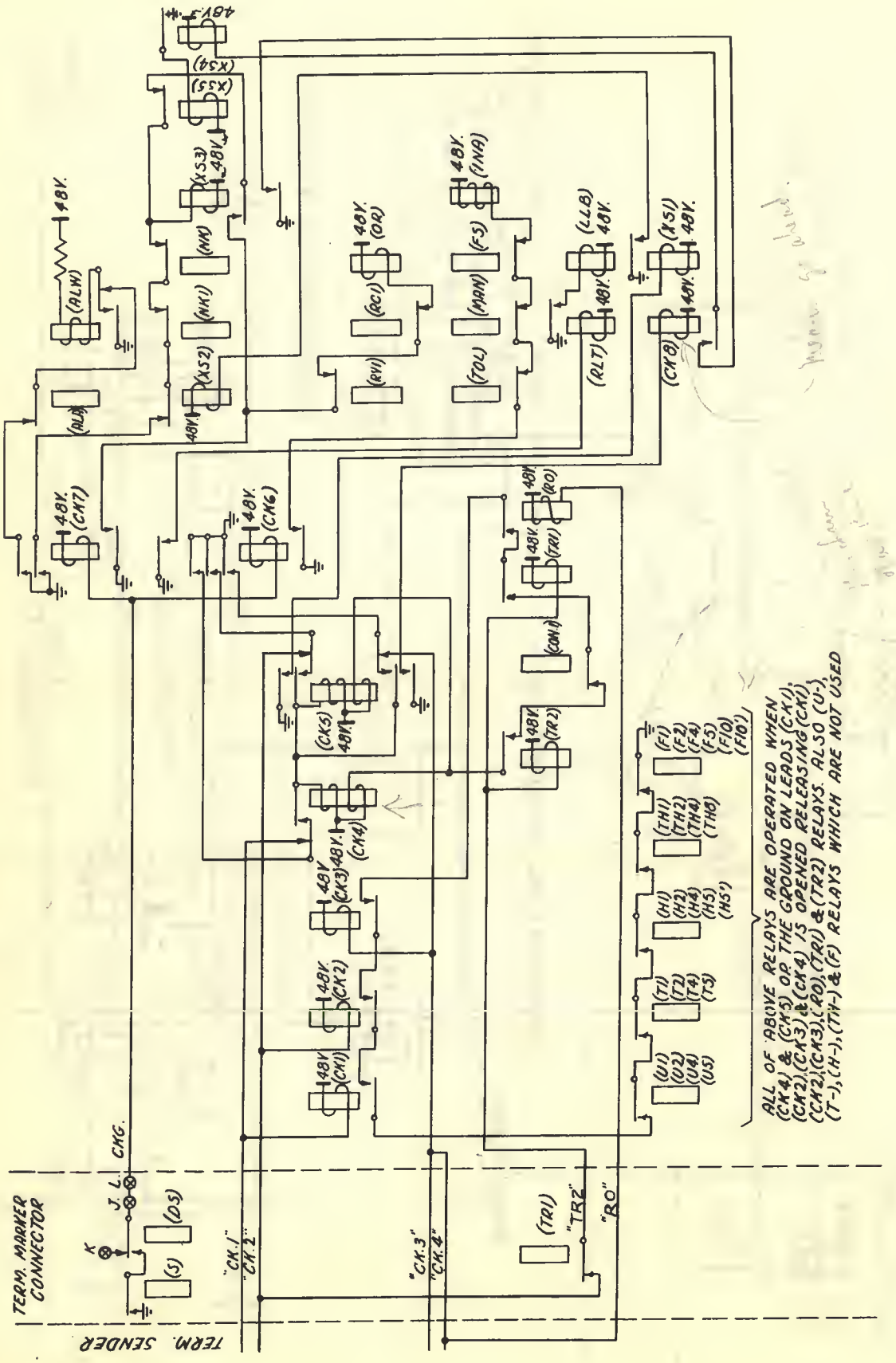


Fig. 3 - Terminating Marker Operation and Locking of Relays (CK4) and (CK5)

CHAPTER 23 - SELECTION AND TEST OF CALLED LINE

The number received from the terminating sender is, as discussed in the previous chapter, registered in the terminating marker on the numerical recording relays (TH-), (H-), (T-) and (U-). This four-digit number is a code since it represents a particular line located on a given line link frame and in a particular horizontal group on that frame. The terminating marker must translate this code in terms of the location of this number with respect to its line link frame. The marker performs this translation process in conjunction with the number group connector and block relay frames.

TRANSLATION

The translator (in the terminating marker) has the function of locating a group of 100 numerically consecutive terminals among which is the called number, located in a particular number group. As discussed in a previous chapter, a number group consists of marker cut-in relays, one-hundred-block relays and twenty-block relays for a group of lines which terminate approximately 1,000 busy hour calls.

TRANSLATOR

The translator consists of from one to twenty (five hundreds) (FH-) relays and relays (hundreds) (HN0) to (HN4). The (FH-) relays select numerically consecutive blocks of 500 numbers and the (HN-) relays select 100 consecutive numbers out of the selected block of 500 numbers. Twenty block relays (TB0) to (TB4) are used to indicate the twenty-block in the selected one-hundred-block.

The (FH-) relay is operated through the (TH1), (TH2), (TH4), and (TH8) and the (H5) and (H5') recording relays depending on the first two digits of the number dialed (see Fig. 1). The (FH) relays have a numerical designation corresponding to the one-thousand-block and for each one-thousand-block the (FH) relay for the second five-hundred-block is distinguished by a prime designation. Thus (FH0) is for the first five-hundred-block in zero thousands and (FH0') is for the second five-hundred-block in zero thousands. Assume that relay (FH4'), Fig.1 has been operated for translation on this call. Relays (HN0) to (HN4) are operated through the contacts of the recording relays (H1), (H2), (H4), or (H5), whichever are operated. Assume for purposes of illustration for this call that (HN4) is operated through the recording relays.

As shown on Fig. 1, the operation of the (HN4) and (FH4') relays connects resistance battery to the 4900 "ST" cross-connection point and ground from the (CK6) relay to the "HB" cross-connection point, on the (FH4') relay.

The (FH4') relay in the marker is shown again on Fig. 2. The "ST" cross-connection points of the (FH) relay are cross connected to corresponding punchings for number groups as required. There is an "ST" lead per number group connector per marker. The associated number group connector start leads are brought into each marker to punchings designated "NG-ST0" to "NG-ST24" as indicated on Fig. 2 and are arranged so that the "ST" punchings of the translator (FH-) relays may be cross connected to them. Each one-hundred-block has its own "ST" point for the selection and seizure of a number group connector. Therefore, any one-hundred-block may be located in any number group connector.

On Fig. 2 ST49 is cross connected to ST2 (number group 2) and this completes a circuit from the 266 ohm battery (see Fig.1) through the contacts of translator relay (HN4) through relay (FH4') to operate the marker preference relay in the number group connector circuit representing the particular marker (Fig. 2). When the marker preference relay operates, if it is the preferred relay, it closes a circuit to operate the marker cut-in relays for the particular marker in the number group connector circuit (see Fig. 2). The number group cut-in relays close 240 contacts to establish test and control paths between the marker and the number group. The operation of the marker cut-in relay in the number group connector, cuts through lead "HB1" which operates the (one-hundred-block) HB49 on the block relay frame. One (HB) relay is furnished on the block relay frame per 100 terminals representing five twenty-blocks which may or may not be consecutively numbered. Usually, however, the five twenty-blocks connected to a one-hundred-block relay will be in numerical order.

The translation process in the marker also operates one of the translator twenty-block (TB) relays in the marker. This relay is operated through the (T1), (T2), (T4), or (T5) relays (see Fig. 1). Assume that (TB0) is operated for this call. The operation of this relay closes the "TB0" lead to the hunting progress relays and ground on the "TB0" lead operates hunting progress (HP0) relay as shown on Fig. 3. The (HP0) relay closes ground on the "TB0" lead through the number group connector to the block relay frame to operate the (TB4900) relay on the block relay frame (see Fig. 2). The operation of the (TB4900) relay cuts through the test leads "NS", "NF", and "NC" for the twenty numbers (4900 to 4919) from the marker to the block relay frame.

The "NS" lead is cross connected at the line distributing frame to the sleeve of a line circuit

(see Fig. 4). The operation of the number group connector (TB) relay, therefore, gives the marker access to the sleeves of twenty lines, one of which is associated with the called number.

The "NF" leads also cut through by the (TB) relay must be cross connected on the terminal strip on the block relay frame to indicate the line choice in which the associated number is located and whether the number represents a tip party, ring party, or one of a hunting group. The "NF" punching of an individual line is cross connected to one of twenty punchings designed "RF0" to "RF19" (see Fig. 4). The numerical portion of these designations should correspond to the line choice in which the line selected by the "NS" cross-connection is located. There are forty other cross-connection points designated "HF0" to "HF19" and "TF0" to "TF19" for terminal hunting and tip party lines respectively.

The "NC" punching of a number is cross-connected on the block relay frame to one of the forty punchings designated "HGA0" to "HGA9", "HGB0" to "HGB9", "HGC0" to "HGC9" and "HGD0" to "HGD9". The letters A, B, C, and D of these designations refer to the first, second, third, or fourth line link frames of a line choice and the numerical portion of the designations to the horizontal group of the line link frame in which the particular line appears. The "NC" lead should be cross connected to the "HG" punching which corresponds to the line which is to be associated with a particular number. The "HF", "TF", "RF", and "HG" punchings of the block relay frame are cabled to the number group connector frame and through the marker cut-in relays are connected to the marker as shown on Fig. 5. Assume that the "NS", "NC", and "NF" leads of Fig. 5 are cross connected to the "HF", "TF", "RF", and "HG" punchings, the marker will be enabled to test over the former leads through the block relay frame and back over the latter leads to the marker.

LINE TEST

The marker connects to and tests simultaneously, twenty sleeves "NS" and twenty "NF" leads of the terminals in the twenty-block which was seized as a result of the translation process. As shown on Fig. 5, this is done by connecting twenty (S) relays, one to each "NS" lead cut through by the twenty-block relay and twenty (HT) relays, one to each "NF" lead cut through by the twenty-block relay. The reason for seizing and testing twenty lines at a time is to reduce marker holding time in case the number called should happen to be the first number of a terminal hunting group. A busy line will ground its "S" lead and operate its associated (S) relay in the marker.

Assume that the call under discussion is to an individual line. The "NF" lead will have been cross connected to an "RF" punching in the number group connector frame (see Fig. 5). The "RF" lead is connected in the marker to a like numbered (LC-) relay. For an individual line, battery is connected through the winding of one of the (LC-) relays and through the contact of the twenty-block relay over the "NF" lead to the associated (HT-) relay. Since the (HT-) relay also has battery on its winding, it will fail to operate.

Assume that the associated (S) relay does not operate indicating an idle line, the (L-) relay corresponding to the called number will now operate as shown on Fig. 5. Its operating path is controlled by the setting of the units recording relays in the marker. The operation of the (L) relay completes the selection of the called line by the marker and the marker proceeds to select the required line choice, line link, and horizontal group in which the call is to be completed.

TERMINAL HUNTING

The phrase "terminal hunting groups" refers to groups of numbers which may or may not be consecutive numerically but which the marker hunts over in an effort to find an idle line. The numbers of a terminal hunting group may all be located on the terminals of one twenty-block relay. They may be consecutive but the group may be of such a size that several twenty-block relays may be required. The second case involves a process known as "end-of-block" hunting. Again the group may be of such a size that for traffic reasons it may be desirable to put lines for the group in more than one number group. In this case, the marker will allott succeeding calls approximately equally to the two number groups by starting its testing on alternate calls in different number groups. When the numbers immediately following those assigned to a particular PBX are in use and the last line of the PBX is not the last of a twenty-block and it is necessary to increase the size of the PBX group by using non-consecutive numbers, a process known as "jump hunting" is required. Each of these cases will be discussed under the general heading of terminal hunting.

Since lines in terminal hunting groups are expected to carry heavy loads, it is desirable to distribute such lines as evenly as possible over the line choices and over the horizontal groups in the line choices for the following reasons:

(a) To keep the various line choices the same size if possible.

(b) To prevent excessive overflow signals because of unbalance of load on junctors and links.

(c) To cause as little disturbance as possible in a PBX group if a line choice must be put out of service for any reason.

The arrangement used for distributing lines is such that any number may be connected to any line choice. This is of advantage in connection with the transfer of working lines from one line choice to another without number changes for balancing traffic, for party line fill, and for class of service change reasons.

The "NF" punching of a terminal hunting line, except the last line of each group, is cross connected on the block relay frame to an "HF" terminal of a number group connector corresponding to the line choice in which the associated magnet is located. The last line of a terminal hunting group is treated like an individual line and cross connected to an "RF" punching.

If the first line of a terminal hunting group is idle (see Fig. 5) the marker operates the (L) relay without checking the contacts of the associated (HT-) relay. If it is busy the (S) relay will operate to the grounded sleeve and the associated (HT-) relay will be operated over the "NF" lead cross connected to an "NF" punching and through the contacts of relay (LE-) to ground. The operation of an (S) and (HT) relay passes the circuit for operating their associated (L) relay along to the next (L) relay. The next set of (S) and (HT) relays will, in turn, carry forward this circuit if the associated line is a busy terminal hunting line. This process will continue until one line of the group is found whose (S) relay does not operate indicating that it is idle, in which case its associated (L) relay will operate causing that line to be selected.

Should this path be interrupted by an operated (S) relay and a normal (HT) relay, it is a signal that all lines of the terminal hunting group have been tested and found busy since the last line is cross connected as an individual line and cannot operate the associated (HT-) relay. The (L) relay operating ground, therefore, operates relay (BB) (Fig. 5) through the back contact of the (HT-) relay and a busy back indication is given to the incoming trunk.

END-OF-BLOCK HUNTING

If the (L) relay operating ground is carried forward to relay (HT19) and finds it operated, it indicates that there are more lines in the terminal hunting group but that they are located in some other twenty-block and relay (PG) (Fig. 5) is operated to advance the terminal hunting progress circuit.

Relays (HP0) to (HP8) (Fig. 3) and (PG) and (UT) (Fig. 5) constitute the terminal hunting progress circuit. The function of this circuit is to seize successive twenty-blocks one at a time up to a maximum of five when the last line and preceding lines, if any, in the same terminal hunting group of a twenty-block are busy. This progress is known as "end-of-block" hunting. Relay (PG) operates from the front contacts of relay (HT19) from the (L) relay operating ground (see Fig. 5).

Relay (PG) closes ground to the armatures of even numbered (HP-) relays starting with relay (HP8) as shown on Fig. 3. An even numbered (HP) relay was operated when the previous twenty-block was chosen. The operated even numbered (HP-) relay then operates the associated odd numbered (HP-) relay. This removes the ground which has been operating the twenty-block relay on the block relay frame and it releases. At the same time the (TBW) relay releases followed by the (TLT) relay which removes the operating ground for the (PG) relay (see Fig. 5). The release of the (PG) relay operates the next even numbered (HP) relay as shown on Fig. 3 and in turn a new twenty-block relay operating lead is grounded. When the first twenty-block relay released, the "NS" and "NF" leads were broken, releasing the (S-) and (HT-) relays. When the next twenty-block relay is seized, the (S-) and (HT) relays which have a circuit reoperate. The operation of the odd numbered (HP) relay causes relay (UT) to operate (see Fig. 5), causing subsequent tests to start at relay (S0). This progress continues until an idle line, a busy last line, or a signal that the allotter is to be used is encountered.

SPLIT HUNDREDS

The marker normally regards a block of 100 consecutive numbers as a unit and furnishes an "ST" and "HB" punching per Fig. 2 whereby the one-hundred-block located on one block relay frame can be seized. Under certain conditions, however, a one-hundred-block is considered as five separate twenty-blocks and a split hundreds (SH) relay is provided for the block so treated. The conditions under which this is done are as follows:

(a) When the one-hundred-block contains the directory number of an allotted PBX.

(b) When non-consecutive end-of-block hunting or end-of-block hunting to unnumbered lines is required.

(c) When more than two free lines are required.

Relay (SH) is cross connected to the "ST" punching of an (FH-) relay as shown on Fig. 7. The associated "HB" punching is left blank. Punchings "HB" and "ST" for the several twenty-blocks on relay (ST) are cross connected as shown on Fig. 7. Punching "AL" of the (SH) relay is cross connected to punching "AL" of the allotter circuit for allotted twenty-blocks.

PBX ALLOTTER

The PBX allotter is illustrated on Figs. 6 and 6A. The function of this circuit is to distribute calls to a large PBX group over two number group connectors should the load be excessive for one connector. The (HP-) relays permit the testing of five blocks of twenty lines each or a total of 100 lines in the hunting group. However, by the use of the allotter, two such groups may be assigned to the same PBX group making 200 lines the maximum for any PBX group.

Relays (ALW) and (ALZ) (Fig. 6) function on every call regardless of its kind and operate either relay (AL1) or (AL2) from ground on (ALW). The (AL1) and (AL2) relays are multicontact relays which connect the "ST", "HB", and "TB" leads into one number group or the other. On calls to an allotted PBX, relay (SH) closes one set of leads "ST", "HB", and "TB" (Fig. 7) causing a corresponding set of punchings on one of relays (AL1) or (AL2) to become effective.

The complete operation on this basis may be followed on Fig. 1. An "ST" punching on an (FH) relay (representing a block of 100 numbers) is cross connected to the "SH" punching representing the winding of the (SH) relay. Battery on the "ST" lead through the (FH) and (HN) relays operates the (SH) relay. The (SH) relay closes through in turn the "AL", "TB", "HB", and "ST" leads for the twenty-block of numbers to the

allotter circuit on Fig. 6. If the called number is the directory number of an allotter PBX or any number in the same twenty-block, the (AL) relay will be operated from ground through the (TB) relay on Fig. 1. The cross-connection of the "ST", "HB", and "TB" leads from the allotter relays (Fig. 7) will cause the selection of a twenty-block relay in one number group or the other depending on whether (AL1) or (AL2) is operated.

Having selected the twenty-block, the marker tests the lines and if any idle line is found in the first twenty-block, seizes it in the usual manner. If no idle line is found the marker "end-of-block" hunts until it encounters a busy last line which will be the last line of that PBX in the first selected number group connector. This causes the operation of relay (ALA) on Fig. 6 from the ground which normally operates relay (BB) but which is switched by relay (AL) to the winding of relay (ALA). The operation of relay (ALA) causes the (ALW) and (ALZ) combination to function so that the operated allotter multicontact relay releases and the non-operated one operates. This causes the release of the first number group connector and the selection of another number group connector in which the remainder of the lines of the desired PBX are located. Line test proceeds in the usual manner in the second number group connector. If a busy last line is encountered in the second number group connector, the (BB) relay is operated through contacts of the (ALB) relay which switched back the lead which formerly operated relay (ALA). Busy back is then returned as described in a later section.

The allotter is normally used with PBX's whose calling rate is such that more than 1,000 busy hour calls would be directed into one number group connector. It may also be used to distribute calls to two number group connectors to reduce the hazard in case a trouble should tie up a number group connector. When used, no other individual line or PBX may be assigned a number in the twenty-block which contains the directory number of the allotted PBX. Regardless of the directory number, an allotted PBX always starts testing on the first line of a twenty-block.

NON-CONSECUTIVE END-OF-BLOCK HUNTING

Terminal hunting groups which extend beyond the first seized twenty-block need not have assigned numbers for lines beyond the first block or if numbers are assigned they need not be consecutive. Once the marker has seized a twenty-block it will continue to end-of-block hunt until an idle line or last line is reached regardless of the number assignments on the lines beyond the first twenty-block. These may be non-consecutive because of the arrangement which permits the windings of the twenty-block relays on the block relay frames to be cross connected to one-hundred-block relay contacts. A split hundreds (SH-) relay must be provided for hundred blocks of numbers containing the directory number of a terminal hunting group whose numbers are not in consecutive order.

Fig. 8 illustrates the method of handling a case of this kind. This assumes that a PBX group whose directory number is 2960 is to grow over twenty lines and that the number 2980 is not available. Under these circumstances, any idle twenty-block, say 3360, is to be used to be hunted to. The 29 hundred block has an (SH-) relay which will be operated whenever (FH2') operates. With 2960 dialed, (HB29) and (TB960) on the block relay frame will be operated. In the normal end-of-block hunting process the progress will be shifted from (TB3) to (TB4) by the hunting progress relays allowing TB2960 to release and operating TB3360 instead of TB2980. This is due to the fact that (TB4) on (HB29) is cross connected to TB3360 instead of to TB2980.

In order to reach 2980 which has been assigned elsewhere, the unused "TB3" punching on the (HB33) relay is used. This is cross connected to the winding of (TB2980). When 2980 is dialed, the same (SH) relay will be operated but (HB80) will be effective instead of (HB60), (HB80) is cross connected to operate the (HB33) relay on the number group connector frame instead of (HB20) as would normally be the case. Lead "TB80" operates the (TB2980) relay through the contact of relay (HB33) instead of (HB29) as would normally be the case. The marker in effect, due to the change in cross connections, translates the dialed number 2980 into 3360.

JUMP HUNTING

This is a type of terminal hunting progress which is principally used to increase the size of a terminal hunting group without changing numbers when the numbers following the group have already been assigned to subscribers. It reduces the necessity of leaving spare terminals following lines or groups which may never grow. The marker can jump hunt after end-of-block hunting and end-of-block hunt after jump hunting.

There is no assurance that the last terminal of a regularly assigned terminal hunting group will be the last number of a twenty-block nor will the terminal jumped to necessarily be the first number of the twenty-block jumped to. Lines jumped to need not be numbered. If the hundred block jumped to is in the regular numbering system it may be used for numbers called directly as well as for numbers jumped to. The (HB24) one-hundred-block of each number group is reserved to be jumped to. This offers a regular equipment arrangement for each number group regardless of size.

Fig. 9 illustrates the principal of jump hunting. The last number of the original PBX group is used as the starting point for jump hunting. It will usually be some other terminal than the twentieth of a twenty-block, must be specially cross connected and is, therefore, not available for cross connection to a line circuit. The "NF" and "NC" punchings of this terminal are cross connected to jump hunting punching fields on the block relay frame, the "NS" lead being left unconnected at the line distributing frame as shown on Fig. 9.

The "NF" lead is cross connected to one of punchings "JF0" to "JF4" corresponding to the five twenty-blocks in the one-hundred-block jumped

to (HB24). The "NC" is cross connected to one of ten punchings designated "JC0" to "JC18" corresponding to ten even numbered "start" points in the twenty-block jumped to.

The "JF-" and "JC-" leads are carried to the jump hunting circuit in the marker through the marker cut-in relays of the number group connector. The relays in the jump hunting circuit operated by these leads open the circuit which operated the original (HB-) relay on the block relay frame and close a circuit for operating the (HB-) relay corresponding to the one-hundred-block and the (TB-) relay for the twenty-block jumped to. In addition, the path to an (L-) relay provided by the recording relays is opened and a new start point for operating an (L) relay is provided as determined by the start point cross-connection on the block relay frame at the "JC-" punchings.

From this point the line test proceeds in the usual manner.

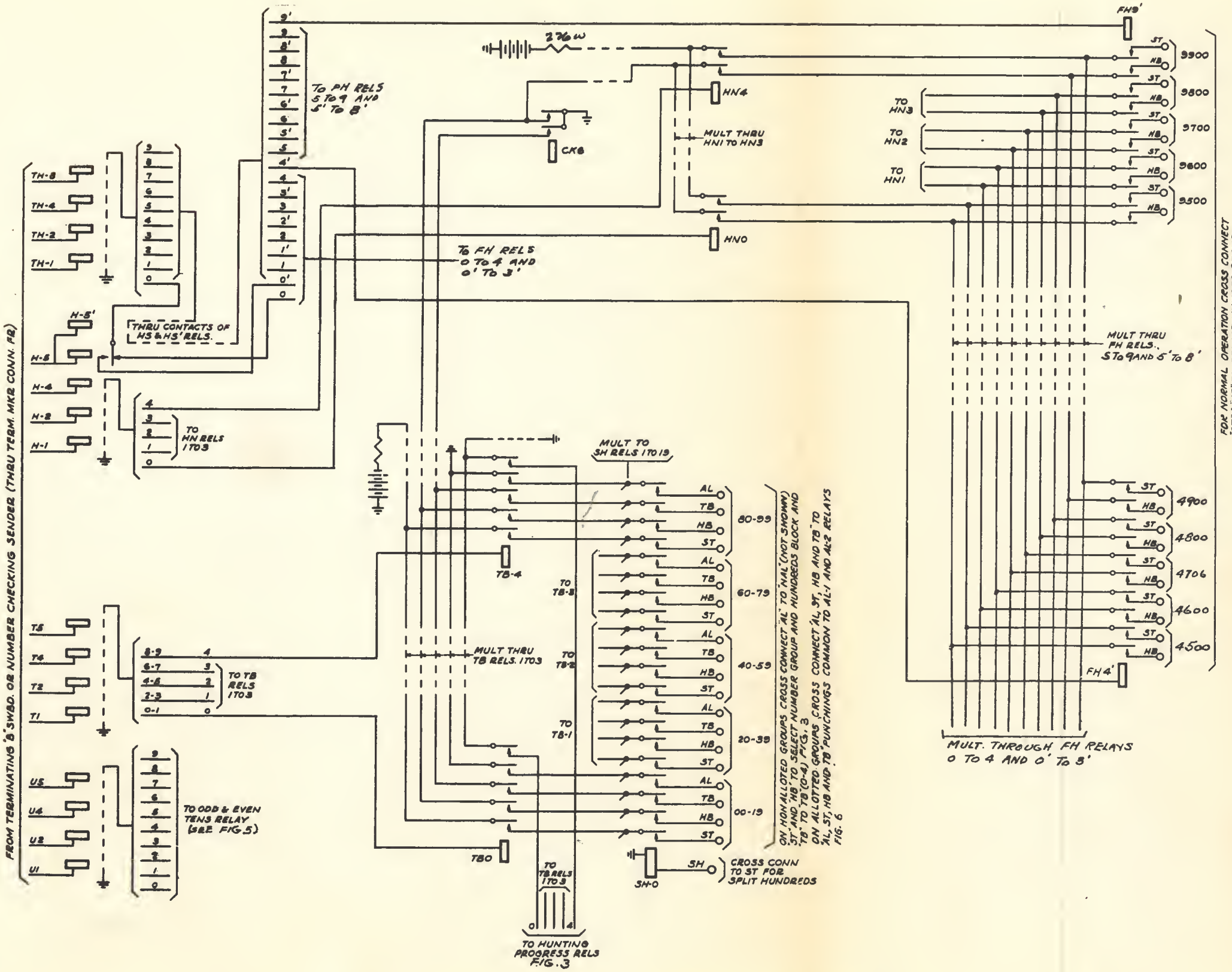
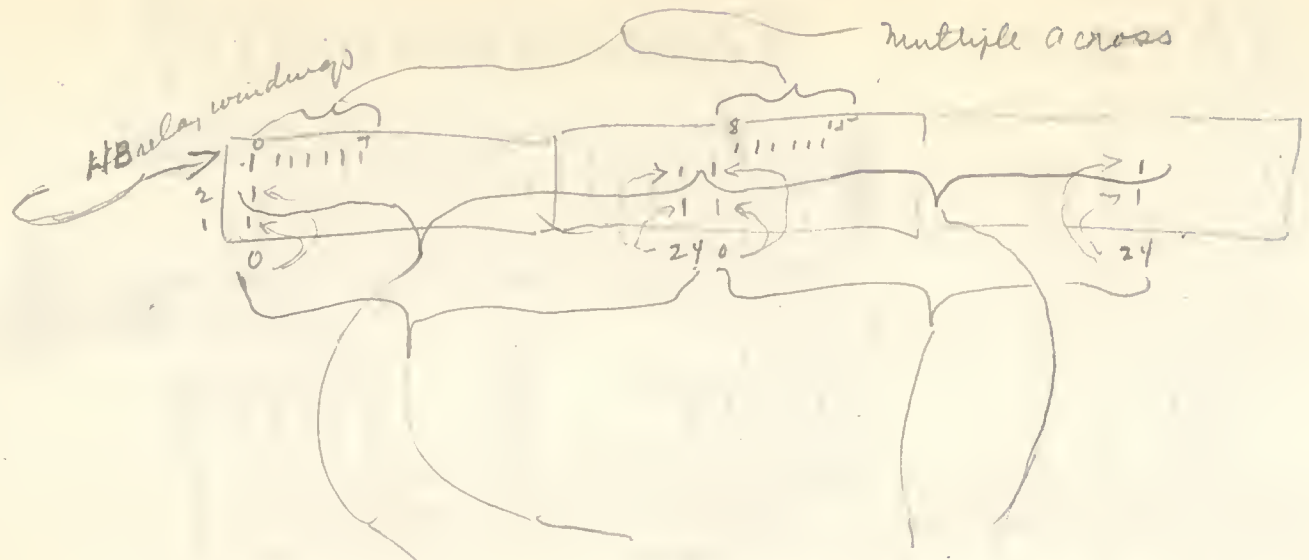


Fig. 1 - Numerical Register; Five Hundreds, Hundreds and Twenties Selection and Split Hundreds Relays

Block Relay Frame



4 number groups max. per frame.

See Drawings { SED 25 368 - 011
ED - 25 368 - 012

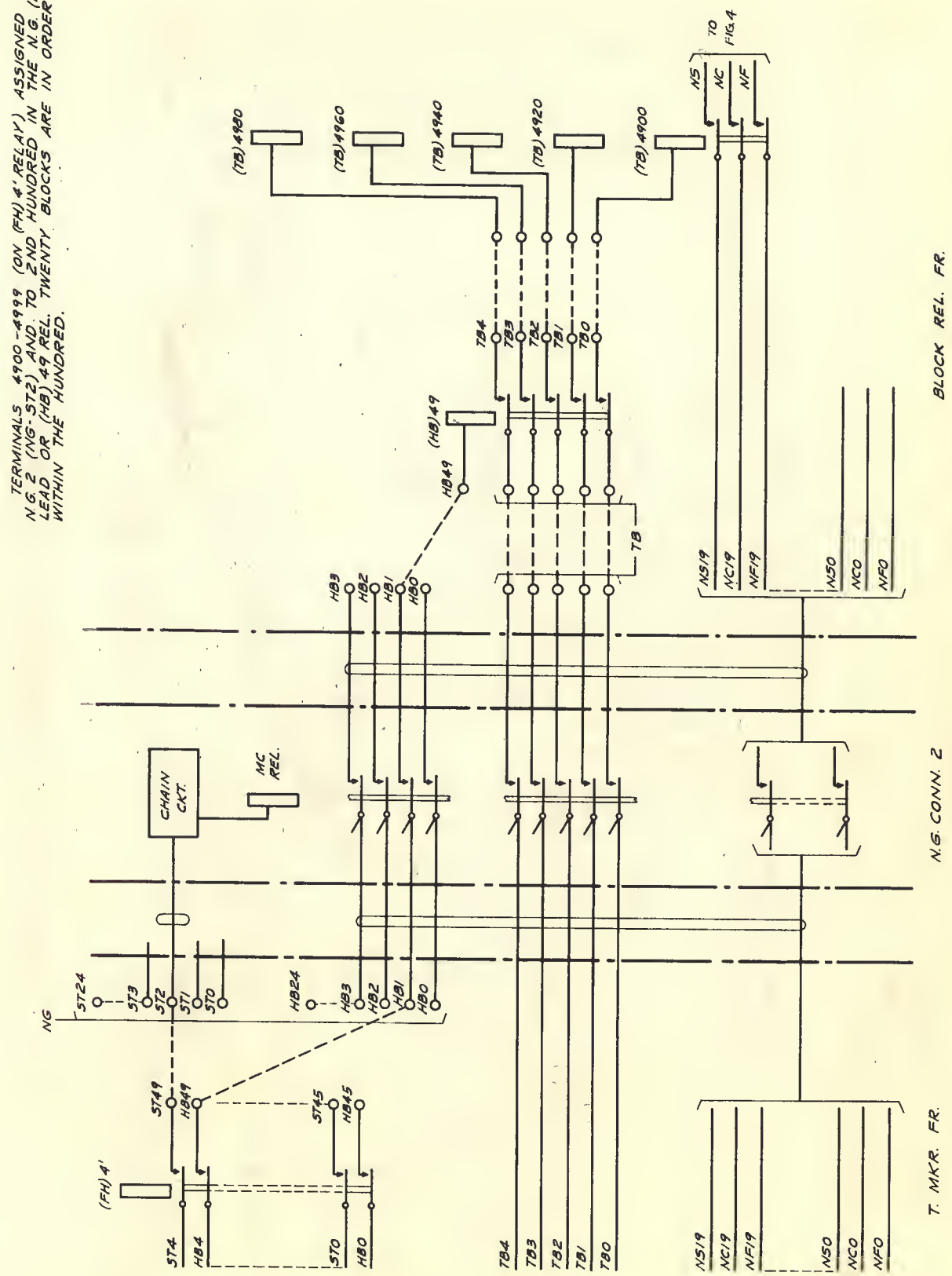


Fig. 2 - Marker Cross-Connections for Regular Assignment

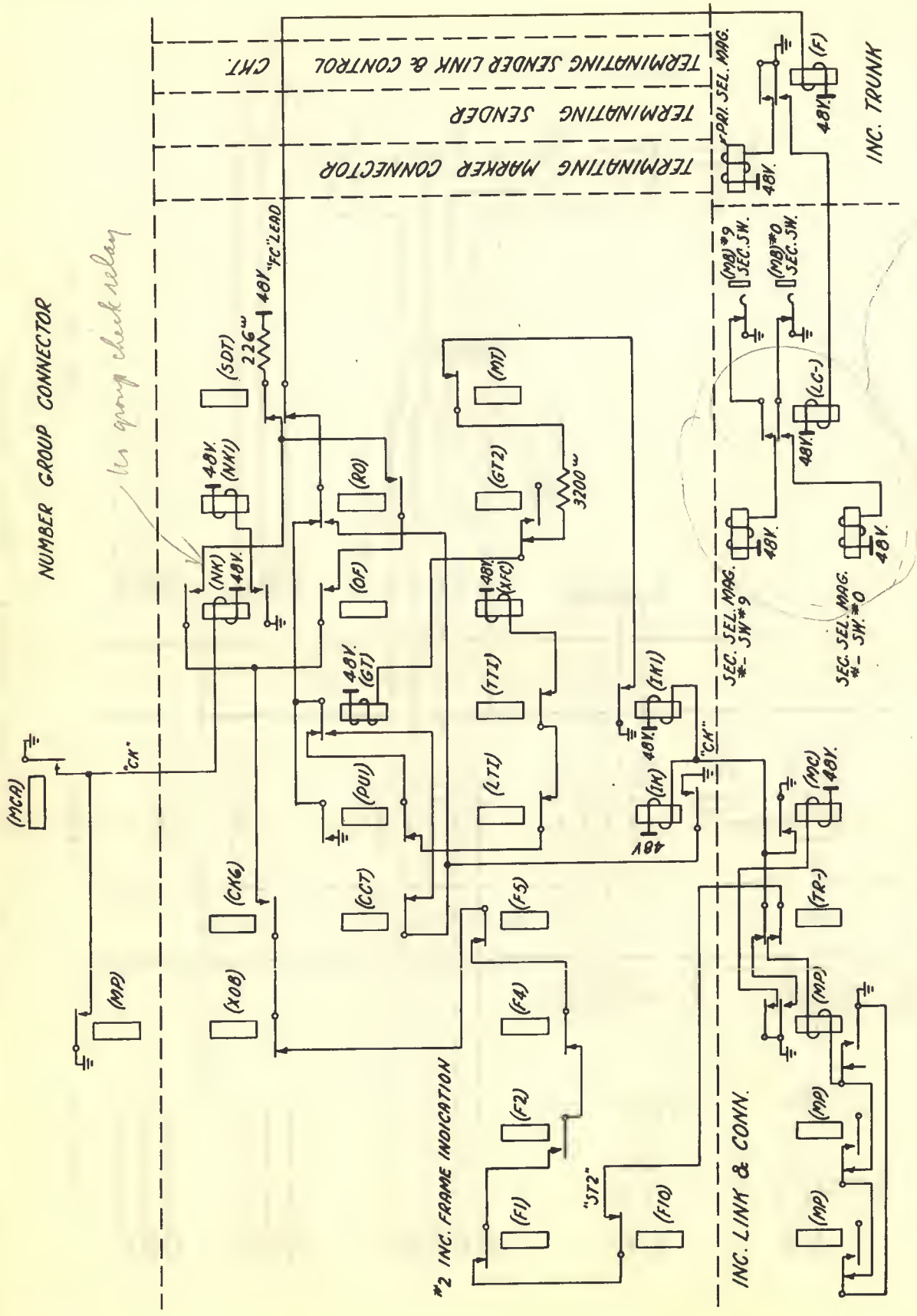


Fig. 2A - Terminating Marker - Associating Number Group Connector with Incoming Link and Connector Circuit which Serves the Incoming Trunk

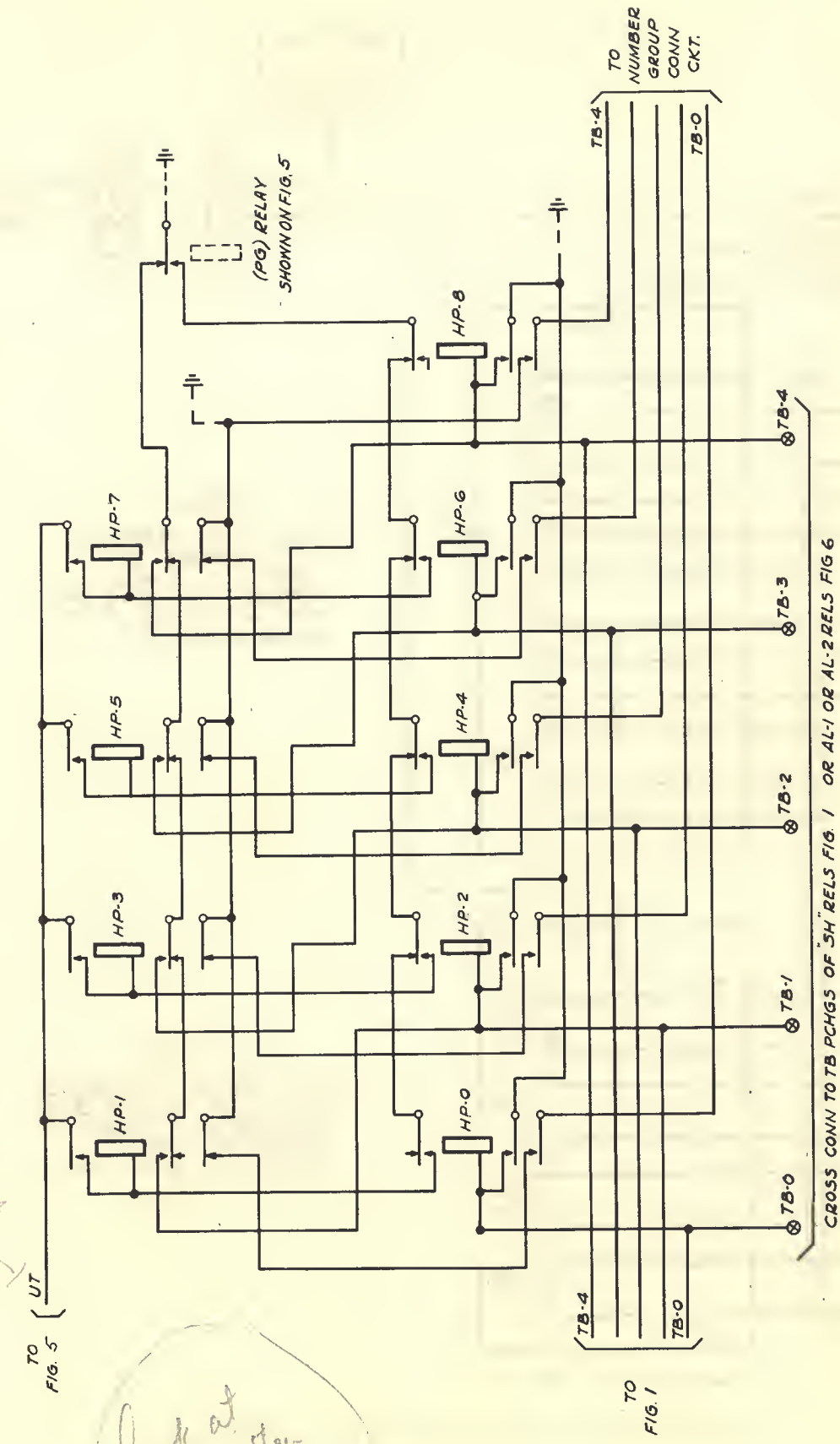


Fig. 3 - Hunting Progress Relays

look at Mem hatter Fig 133 M

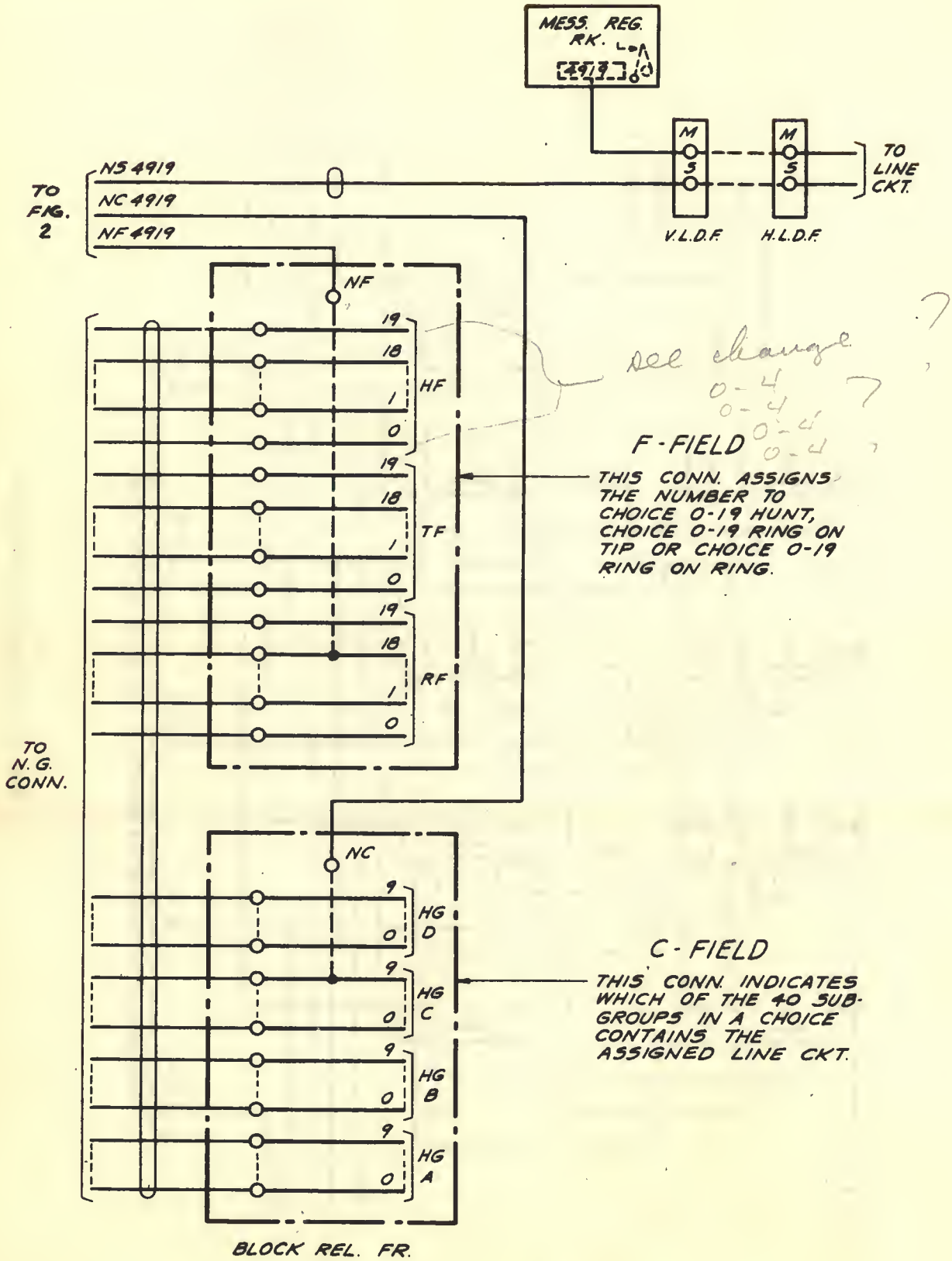


Fig. 4 - Cross-Connection of "NS", "NC", and "NF" Leads

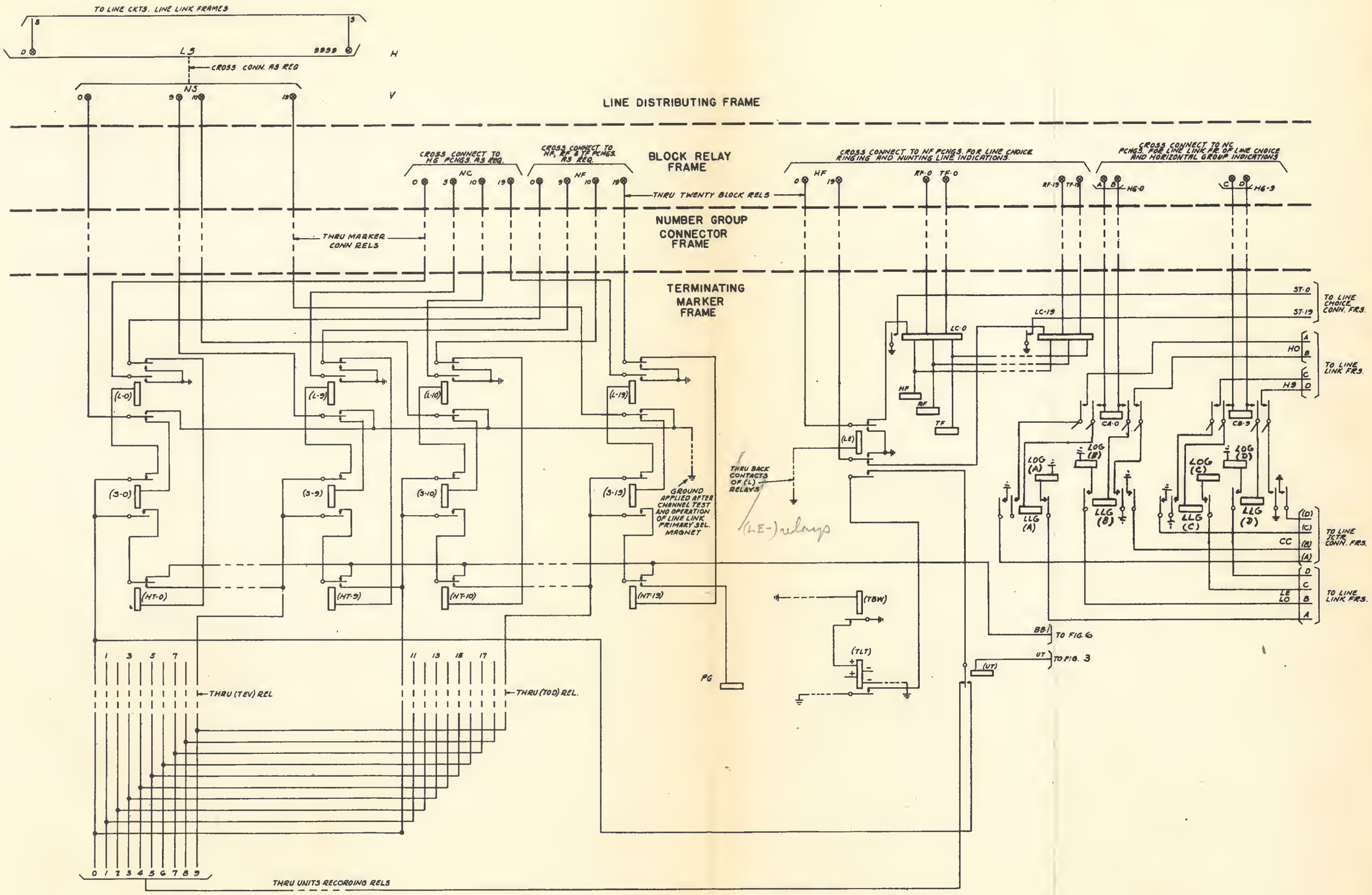


Fig. 5 - Line Test and Terminal Hunting

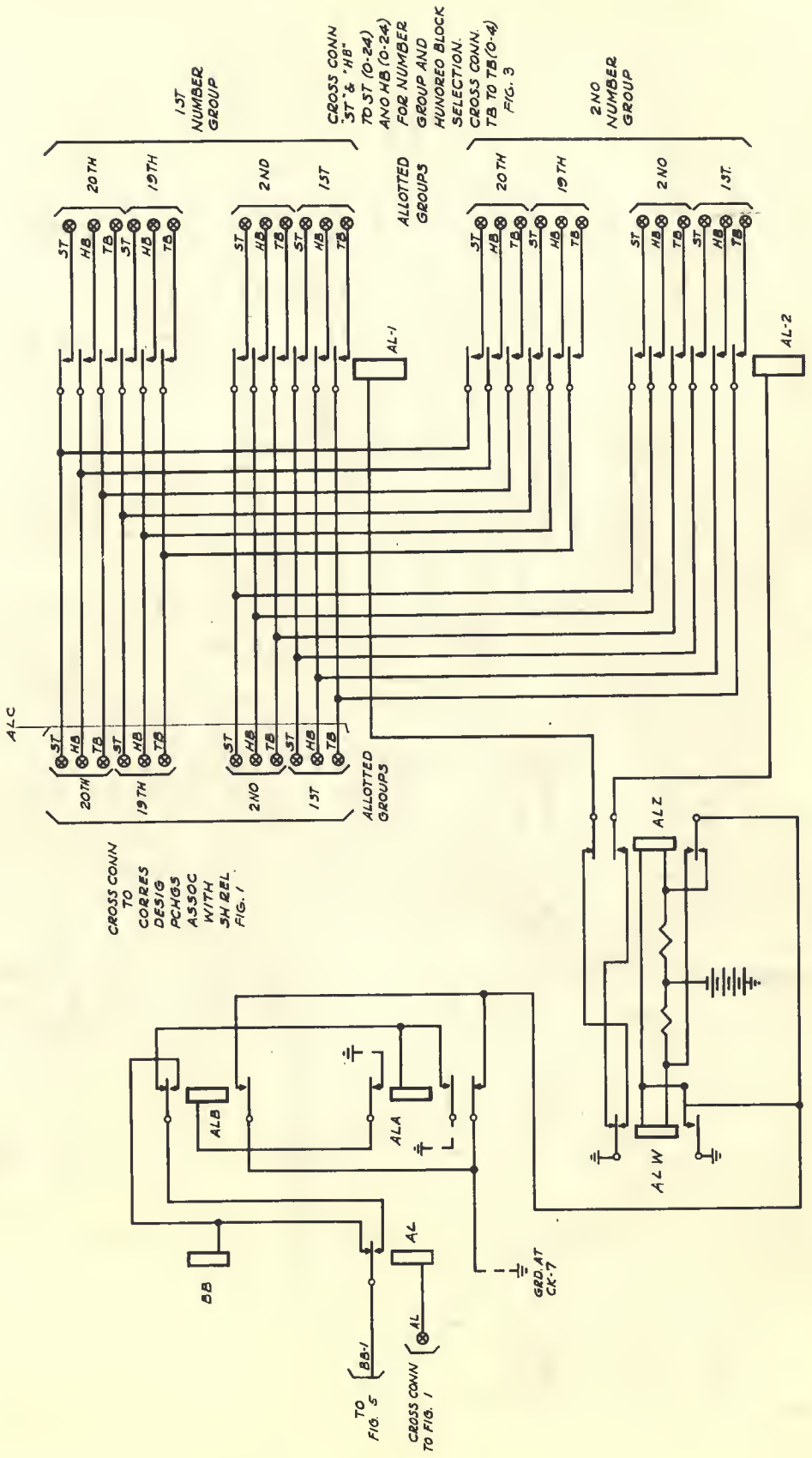


Fig. 6 - PBX Allotter

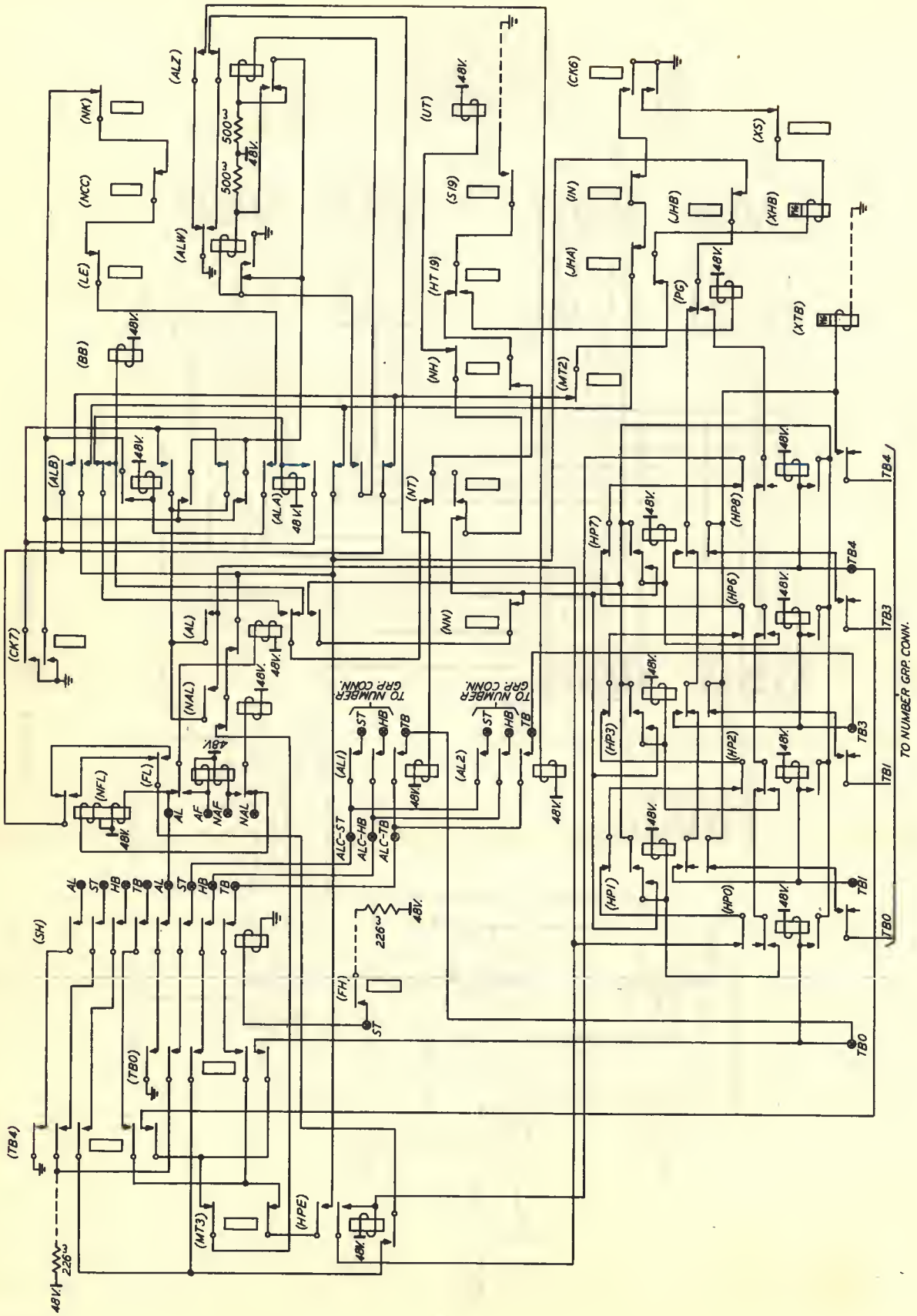


Fig. 6A - Terminating Marker PBX Allotter and Free Lines

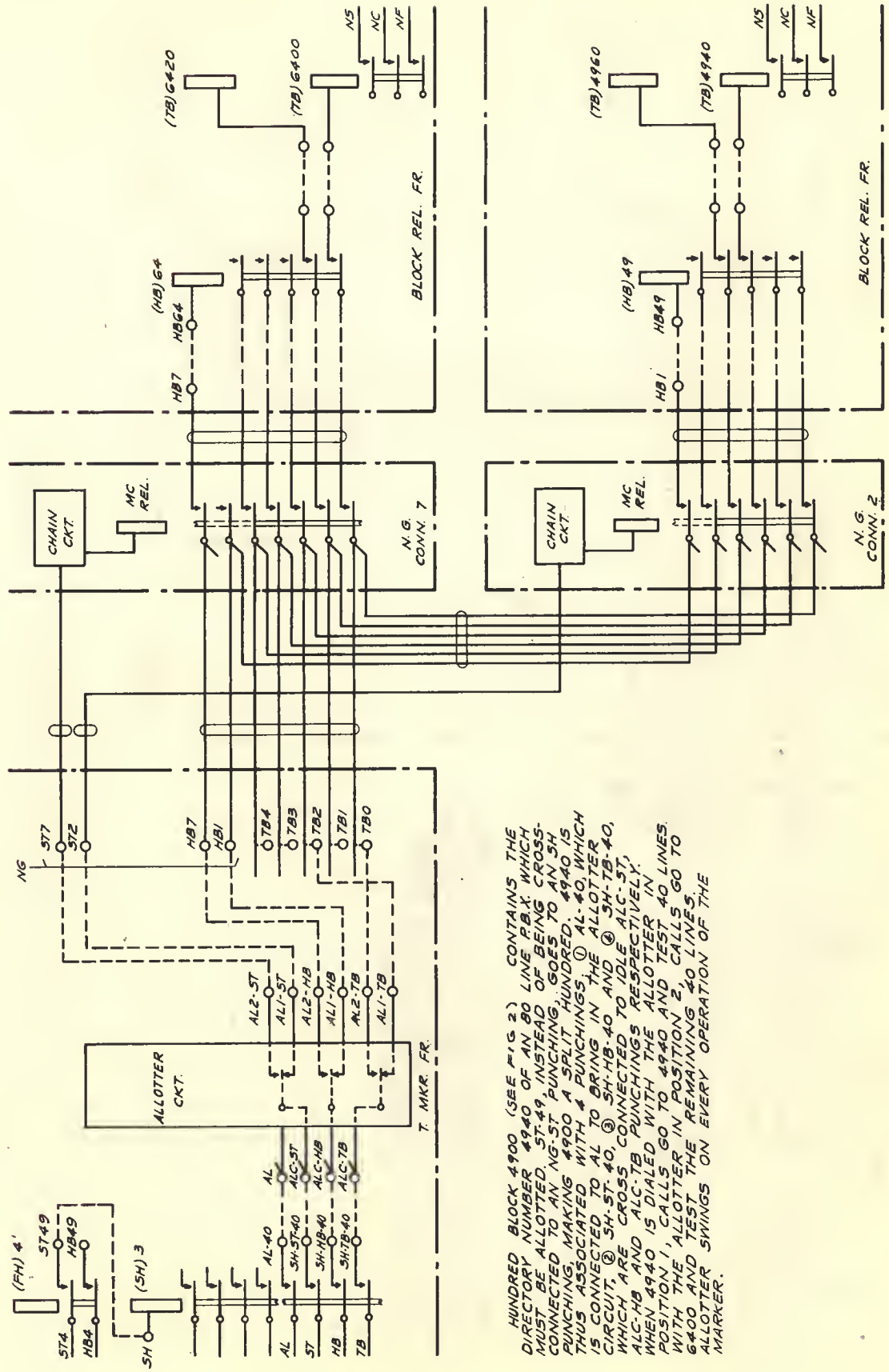
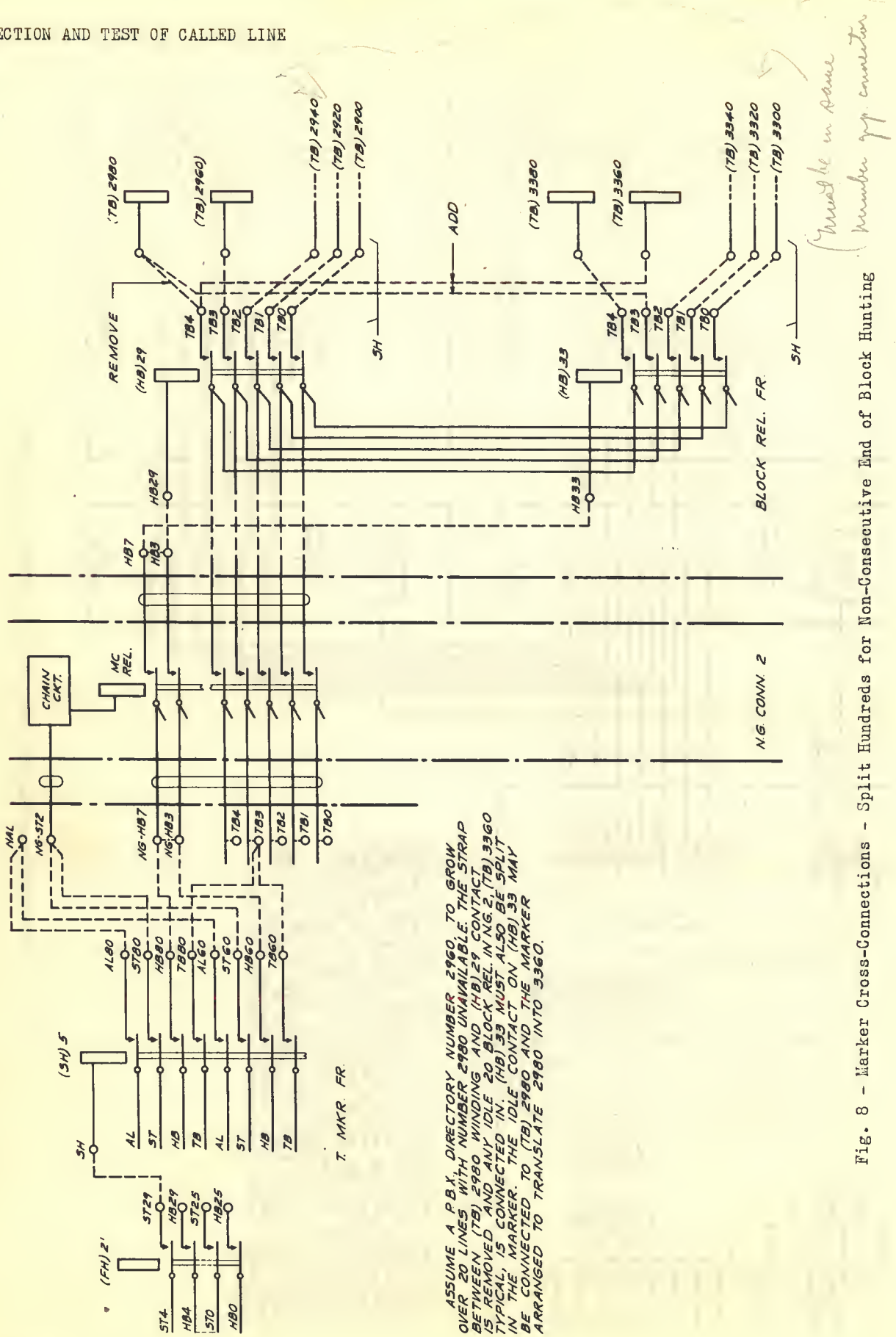


Fig. 7 - Marker Cross-Connections - Split Hundreds for Allotting



ASSUME A P.B.X. DIRECTORY NUMBER 2960, TO GROW OVER 20 LINES WITH NUMBER 2980 UNAVAILABLE. THE STRAP BETWEEN (TB) 2980 WINDING AND (HB) 29 CONTACT IS REMOVED AND ANY IDLE 20 BLOCK REL. IN NG. 2, (TB) 3360 TYPICAL, IS CONNECTED IN. (HB) 33 MUST ALSO BE SPLIT IN THE MARKER. THE IDLE CONTACT ON (HB) 33 MAY BE CONNECTED TO (TB) 2980 AND THE MARKER ARRANGED TO TRANSLATE 2980 INTO 3360.

Fig. 8 - Marker Cross-Connections - Split Hundreds for Non-Consecutive End of Block Hunting

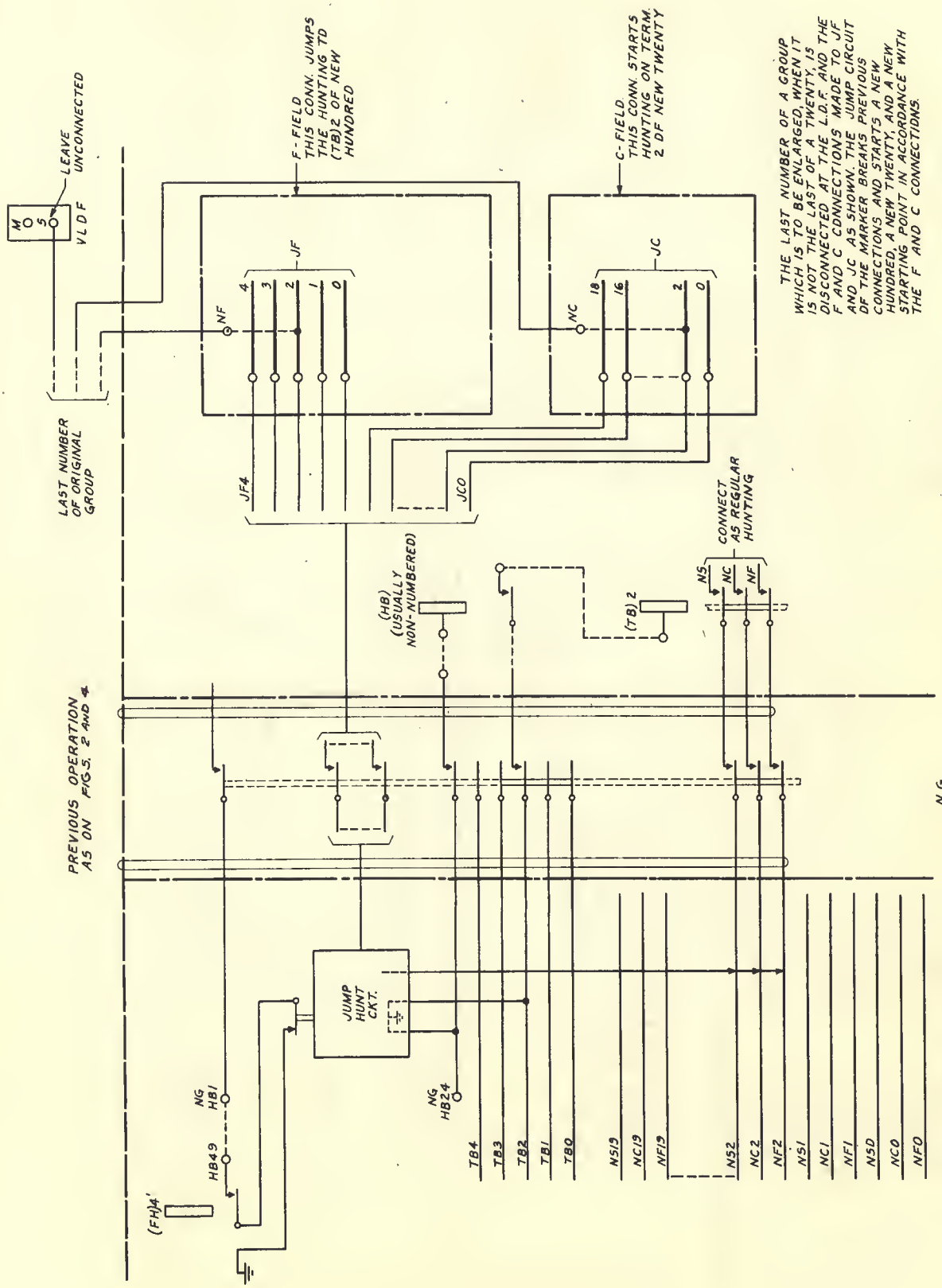


Fig. 9 - Marker Cross-Connections - Jump Hunting

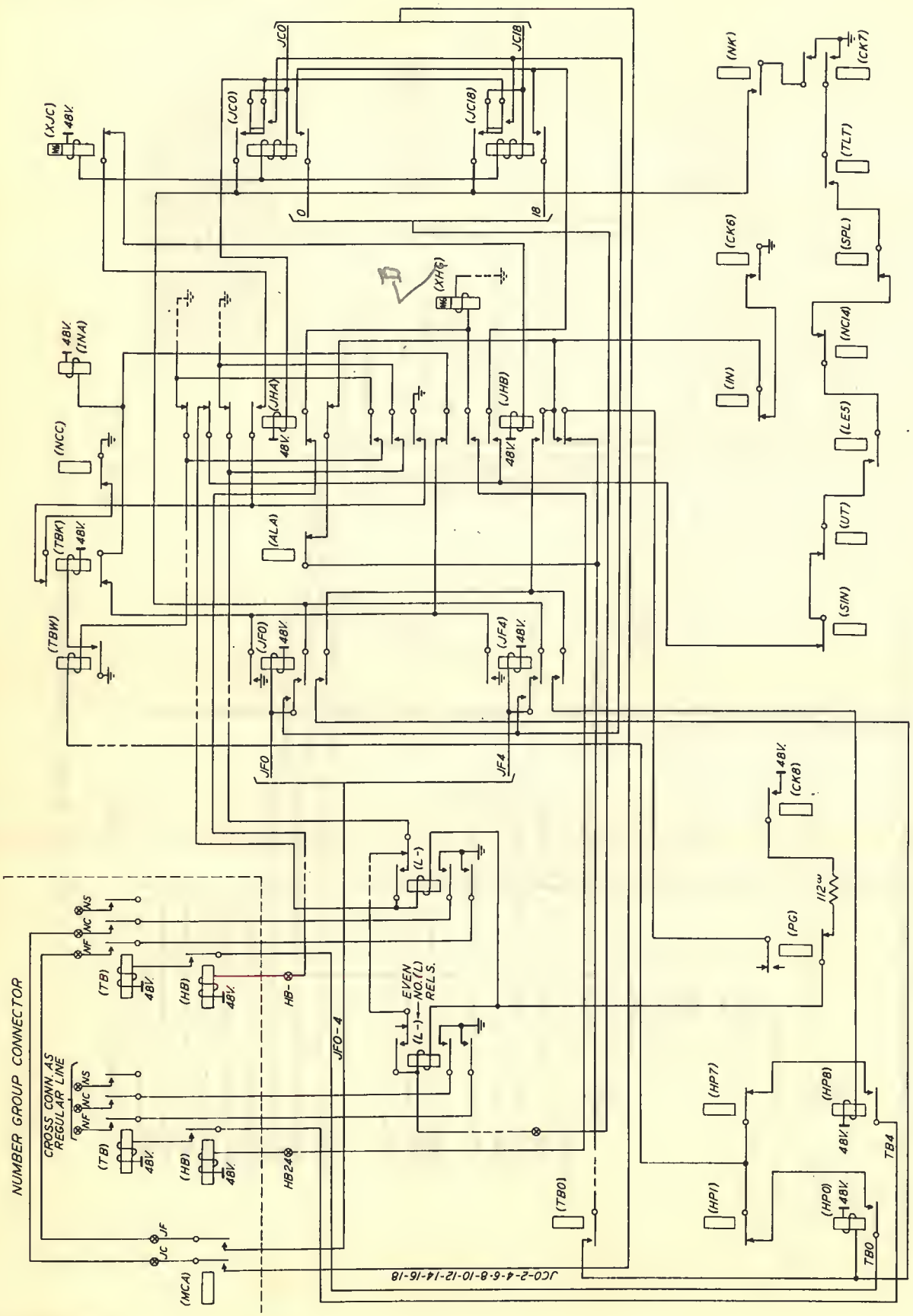


Fig. 9A - Terminating Marker Jump Hunting

CHAPTER 24 - SELECTION OF CHANNEL AND OPERATION OF SWITCH MAGNETS

When an idle line is selected, the corresponding (L) relay is operated and grounds the "NF" lead as shown on Fig. 5 of Chapter 23. This ground through the cross-connection in the number group connector circuit operates a triple-wound (LC-) relay in the marker corresponding to the line choice number in which the selected line is located. The three windings of the (LC) relay represent an intermediate PBX line, a ring party or individual line (including a last PBX line) and a tip party line and they terminate respectively on "HF", "RF", and "TF" punchings. The (LC) relay is operated on the winding corresponding to the type of line selected. The cross-connections on the block relay frame are made as shown on Fig. 4 of Chapter 23 in accordance with the type of line.

The operation of an (LC-) relay closes the start lead to the correct line choice connector frame, as shown on Fig. 1. (There is a maximum of 20 (LC-) relays, one for each line choice up to a maximum of 20 line choices.) As in the case of the number group connector each marker has a start lead and a preference relay in each line choice connector and operates this relay in the same manner. With the preference relay operated, three multicontact relays (per marker) are operated to connect the line choice equipment to the marker.

LINE GROUP SELECTION AND LOCKOUT

When the (L) relay operates it also grounds the "NC" lead as shown on Fig. 5 of Chapter 23 through the cross-connections in the number group connector, as explained in the previous chapter, and operates one of twenty double-wound relays (CA0) to (CA9) and (CB0) to (CB9) over an "HG" lead. The numerical portion of the designation of these relays indicates the horizontal group in which the selected line is located and the "A" or "B" indicates the half choice. As indicated in the above figure, the ground which operates the (CA) or (CB) relay is carried through a contact to operate one of relays (LLGA) to (LLGD) to indicate in which of the four line groups of the choice the selected line is located. The operated (LLG) relay closes the corresponding double-wound (LOG) relay to leads "LE" and "LO" for the purpose of operating the (LA) or (LB) relays in the line link control circuit as indicated on Fig. 2. A double-wound (LOG) relay is required because the throw-over arrangement between the regular and mate control circuits of the line group does not throw over the lock-out lead. Therefore, it is necessary for the terminating marker to lock out both the regular and the mate control circuit in all cases. The cut-off arrangement of the (LOG) and (LA) or (LB) relays is such that a terminating call is given preference when it starts simultaneously with an originating call.

The following additional information is obtained from the (LLG) relay. Relays (LLGA) and (LLGB) operate relay (HCA) of Fig. 3 to indicate half choice A and relays (LLGC) and (LLGD) operate relay (HCB) of Fig. 3 to indicate half choice B. Each (LLG) relay also grounds a correspondingly designated "LR" lead (not shown) to the line link control circuit. Should the line link control circuit be held on an originating call because of an all senders busy condition or all districts busy condition the "LR" lead ground would release the control circuit and permit the terminating marker to seize it.

Other contacts on the (LOG) relay ground contacts on the (CA) or (CB) relays which in turn operate the (HG) relay in the line link control circuit over an "H" lead as indicated on Fig. 5 of Chapter 23 and Fig. 1 of this Chapter. The (CR) and (CE) relays in the line choice connector circuit shown on Fig. 4 which cut through the line link test leads and miscellaneous leads are operated by the corresponding (LOG) relays.

The terminating marker can test a line prior to testing the line choice or control circuit and while the line link control circuit is locked out by a terminating call the other three control circuits in a choice may originate calls. Only one terminating call may be completed in a line choice at one time.

MATE FRAME LOCKOUT

In offices with an ultimate of more than ten incoming frames the secondary holding magnets of two incoming frames are multipled and the pair of incoming frames are then described as mate frames. Since a marker may be connected to each incoming of a pair through the associated incoming connector it is necessary to prevent the operation of secondary selecting magnets on one of a pair of incomings when the selecting magnets of the other frame are in use. The incoming frame is, therefore, provided with a regular and an emergency set of preference relays and auxiliary relays for closing the secondary selecting magnet leads. The preference relays are operated by the marker when relay (LOGA-D) operates.

On first trials the marker seizes the selecting magnet lockout circuit by placing 226 ohm battery on lead "MPS" which operates the (FP) relay in the incoming connector, if available, as shown on Fig. 4. This in turn operates the auxiliary (RS) relay which signals the marker over

the "MKO" lead that the preference circuit has been seized. It also signals the marker attached to the mate frame over an "MK1" lead (not shown).

CONNECTING LINKS AND JUNCTORS TO MARKER FOR TESTS

The incoming trunk on which a call is waiting appears on a horizontal of a primary switch on an incoming link frame. It has access to twenty incoming links through the verticals of the primary switch and may set up a call through any one of the twenty links. The sleeve leads for the twenty links which serve a group of ten incoming trunks are brought to a link cut-in (LC) relay in the incoming connector which may be operated by the (F) relays of any one of the ten associated incoming trunks as shown on Fig. 4. The (F) relay of the incoming trunk is operated by the marker through the terminating sender. The connection of the proper group of twenty links is, therefore, determined by the incoming trunk.

LINE JUNCTOR DISTRIBUTION

A complete line choice is made up of four line groups, two of which constitute half choice A and the other two half choice B. On Fig. 3 line link frames 0 and 1 constitute half choice A in line choice 0 and line link frames 2 and 3 constitute half choice B. The two line groups of half choice A are known as the A and B line groups and the two line groups of half choice B are known as the C and D. Each line group (line link frame) has 100 secondary holding magnets for use with line junctors for terminating calls. The corresponding line junctor holding magnets of the two line link frames in the same half choice are multipled together as shown on Fig. 3, and connected to 100 line junctors. These line junctors may connect to 100 incoming link seoondary holding magnets without mate frame operation or to 200 incoming link secondary holding magnets where mate frame (build-out) operation is employed as is the case on Fig. 3. Each group of 100 line junctors may be considered to be made up of ten vertical columns or rows of ten junctors each on the incoming link secondary switch. Each vertical row corresponds to a vertical row of holding magnets in the two line groups which use a group of 100 line junctors in common. Where build-out is employed as on Fig. 3 the corresponding verticals of incoming link secondary switches are multipled together and the vertical columns correspond to those of the A half choices of line link frames. The corresponding verticals of build-out incoming link secondary switches are multipled together and the vertical columns correspond to those of B half choices of line link frames.

The test leads of each vertical row of ten junctors plus leads to the twenty associated holding magnets on the line link secondary switches are cut in to the marker by a multicontact relay in the line choice connector designated (LJA) for half choice A and (LJB) for half choice B with a numerical designation corresponding to the vertical row of holding magnets in the line group (see Fig. 3). This relay, therefore, corresponds to a vertical row of ten holding magnets on each of the two line groups forming a half choice and also, when junctor patterns are not involved, to an associated row of holding magnets on an incoming link frame without build-out or on each of two incoming frames (or build-out frames) when build-out is used.

Where junctor patterns are involved, as will be explained later, a vertical row on one line choice may terminate in several incoming frames depending on the size of the office.

OPERATION OF JUNCTOR CUT-IN RELAYS

Fig. 3 illustrates the method of operating the junctor cut-in relay for the particular half choice required. Its operation depends on some or all of the following factors:

(a) The number of the incoming frame on which the incoming trunk making the call is located.

(b) The number of the line choice in which the called line is located.

(c) The half choice in which the called line is located.

(d) The setting of the junctor relay retest circuit which may vary from call to call when more than ten junctors may serve a call.

On Fig. 3 the (JGA) to (JGE) relay is controlled by the junctor relay test circuit as discussed later. The (HCA) or (HCB) relay is operated, as already explained, depending on the half choice indication received over the "NC" lead from the block relay frame. The (JA) or (JB) relay operated in the marker depends on the number of the incoming link frame. (Incoming link group in this case.) The (MC) relay of the line choice connector is operated from the marker, as previously explained, depending on the line choice indication received by the marker over the "NF" lead.

The (LJA-) or (LJB-) relays of the line choice (located on the line junctor connector frame) are operated as indicated on Fig. 3. Relays (JA-0) to (JA-6) (only 7 incoming groups shown) and (JB-0) to (JB-6) operate from ground in the incoming connector over leads "JR0" to "JR6" respectively. The (JA) or (JB) relay operated connects battery to the corresponding "JA" or "JB" lead to operate the (LJA) or (LJB) relay in the line choice connector. Ground (not shown) is connected to all other "JA" or "JB" leads thus short-circuiting the windings of the corresponding relays in the line choice connector in preventing their false operation due to crosses in the wiring.

The selection of the group of ten line links which can serve a particular call is made when the line is selected. As previously discussed, the ground applied to the "NC" lead by the marker (L) relay operates one of the (CA-) or (CB-) relays through whose contacts the line group (HG-) relay for the particular horizontal group operates. The operation of the (HG) relay cuts through the test leads for ten line links through marker cut-in relays of the line choice connector. This is indicated on Fig. 4.

CHANNEL TEST

The layout of links and junctors is such that on any one call and on a particular channel test there are not more than ten channels over which a call from a particular incoming link frame to a selected line can be set up. However, there may be more than ten junctors available for completing the call and these will be tested in conjunction with the incoming links and line links on subsequent channel tests.

The process of testing the channels is similar to that previously described for testing channels in the originating marker. Ten sets of relays are furnished for testing channels. Each set consists of a double-wound (AB) relay to test an incoming link and a line junctor and an (LL) relay to test a line link. Fig. 4 shows how the test leads for the various channels are cut into the marker.

There are ten (CH-) relays corresponding to the (AB-) and (LL-) channel test relays. A (CH-) relay will operate after the (TK) relay has operated to indicate that the cut in relays on the incoming and line link frames have operated (Fig. 6) if there is an idle channel and will represent the first idle channel in the order of testing as determined by the operated (AB-) and (LL-) relays for busy channels. The channel test leads are carried to the (AB-) and (LL-) relays through the back contacts of the associated (CH) relay in each case. The (CH-) relay operated transfers the test leads for the channel to a testing circuit preparatory to operating the holding magnets. However, this testing circuit is not immediately applied but waits an interval to insure that the holding magnets have had sufficient time to release from a previous call in case the channel was seized immediately after having been released. The end of this interval is determined by the release of relay (HMT-1) (see Fig. 4) which has been held operated in a local timing circuit.

When the (CH-) relay operates it prepares a circuit for operating the line link primary selecting magnet as shown on Fig. 4 and connects a line link secondary holding magnet to the line junctor sleeve. The selecting magnet circuit is not directly closed when the (CH-) relay operates but awaits the release of the (TE) relay to avoid a momentary ground on a selecting magnet lead in case more than one (CH-) relay temporarily operates before the chosen (CH-) relay locks. When the (TE) relay is released, ground is applied over the "SM" lead to operate the line link primary selecting magnet.

OPERATION OF INCOMING LINK AND LINE LINK SELECTING MAGNETS

The incoming link primary and secondary selecting magnets and the line link secondary selecting magnet are not controlled directly by the marker. The primary selecting magnet of the incoming link frame is associated with the incoming trunk originating the call and is operated by the frame (F) relay of the incoming trunk. In addition the (F) relay closes ringing tone control and in some cases class leads to the marker. It also operates the incoming link frame cut-in relay as previously described.

There are ten incoming link cut-in (LC) relays, each being associated with a group of ten incoming trunks which operate it and which connects to the primary switch whose links are cut in by it. Each relay has ten contacts for operating ten selecting magnets, one on each of the ten incoming secondary switches. The level of the selecting magnets on the secondary switches is the same as the numbers of the corresponding primary incoming switches whose links were cut through by the operated incoming link cut-in relay. In offices with build-out frames, the operation of the secondary selecting magnet awaits the operation of the selecting magnet preference relays (FP) and (RS) (see Fig. 4).

The line link secondary selecting magnets are operated by the (HG) relay in the line link control circuit as indicated on Fig. 4.

OPERATION OF LINK AND JUNCTOR HOLDING MAGNETS

As previously discussed, the operation of a (CH-) relay directs the test leads of the links and line junctor of the chosen channel into a testing and operating circuit after an interval required for holding magnet timing. This is illustrated on Fig. 4. The differentially connected primary and secondary windings of polarized relay (BA) are applied to the sleeve of the incoming link through the operated (CH-) relay over an "R" or "L" lead as indicated on Fig. 4. If this lead is not grounded and has battery on it showing that it is continuous, the (BA) relay will operate. The incoming link primary holding magnets may also operate and cause the operation of relay (SL) in the marker through the crosspoint and over the "SL" lead. This magnet is not required to operate at this time, however, and if it does not, will operate later from ground applied to the line junctor sleeve. Failure of the (BA) relay to operate may indicate any of the following:

(a) Open incoming link test lead.

(b) Open winding on the (AB-) relay resulting in the selection of a busy incoming link.

(c) Double connection resulting in a grounded incoming link test lead when associated holding magnet operates.

At the same time that the incoming link is being tested by relay (BA), the line link which has had battery in series with a 2500 ohm retardation coil connected to it by the operation of relay (HG) in the line link control circuit is being tested by polarized relay (BC) whose primary and secondary windings are connected to the line link over the "LL" lead. The (BC) relay upon finding battery on this lead, locks on its tertiary winding and operates relay (BC1). Relay (BC1) transfers the line link test lead to the winding of relay (GC) as shown on Fig. 4.

With relays (BA) and (BC) operated, ground through the contacts of (BC) and (BA) operates relay (GJ) which locks and grounds the line junctor sleeve through the contacts of relays (CON1), (NC3), (HMT1), and (CH). The junctor holding magnets thereupon start to operate, including the line link secondary holding magnet whose operating circuit is closed to an additional contact of relay (CH) and through contacts of relay (EH) or (OH). If the secondary incoming holding magnet operates before relay (GJ), the ground from the line junctor sleeve attempts to release relay (BA) but it holds on its tertiary winding until relay (GJ) has broken the back contact of a continuity spring and locked. When relay (GJ) has operated and locked, the (BA) relay is operated down by the double effect of having its secondary winding grounded and its primary winding shunted. When the line link secondary holding magnet has operated, its operating ground is closed to the winding of relay (GC) which operates and locks and this operates relay (GC1) which opens the line link test lead.

As a signal that all the holding magnets necessary to set up the call except a line holding magnet are operated, relay (SL1) is operated to ground through contacts of relays (LK), (TR), (BC), (BA), (GC), and (SL).

FALSE CROSS AND GROUND TEST

A false battery on the tip, a false ground on the ring or a shorted tip and ring in incoming or line switches will operate the supervisory relay of the incoming trunk regardless of the status of the called line. The function of the (FCG) relay, Fig. 1, Chapter 25, in the marker is to detect these conditions. Incidentally, it may also detect certain double connections.

Should the (FCG) relay operate, it will open the line holding magnet operating ground. The marker will block in this condition and time out.

OPERATING THE LINE HOLDING MAGNET

To save marker holding time in intervals when the demand for markers is heavy, the marker varies the method of operating holding magnets depending upon whether traffic is light or heavy. When traffic is light the marker delays the operation of the line holding magnet until the (FCG) relay has checked for false cross and ground conditions on the tip and ring up to the line crosspoints. When traffic is heavy, the false charge test is cut off early and the line holding magnet is operated at the same time as the junctor magnets.

Relay (SL1) operated operates relay (GLH) which grounds the line holding magnet over a circuit traced from ground on the (LK) relay contacts over the "NS" lead to the line link frame as indicated on Fig. 4.

The operation of the line holding magnet cuts off the subscriber line relay and closes the tip and ring of the line through the switches and incoming (F) relay to the marker for the crosspoint continuity test.

SELECTION OF LINE JUNCTOR GROUP

If exactly ten or twenty incoming link frames (ten incoming groups) are furnished, only one set of ten junctors is available for a particular call. If any other number of incoming frames is furnished there are more than ten junctors available which can be tested for a particular call. Since each half choice always uses 100 line junctors to reach all incoming frames and since the marker tests only ten junctors at a time, the marker is provided with a retest circuit to select additional junctors, if available, in groups of ten or less when a selected group tests busy.

The marker also prepares to seize a new junctor group for the next call in the interval following the previous call. Following the completion of each call, the marker advances a walking circuit Figs. 5 and 5A consisting of (RT) relays usually keeping two of these relays operated between calls. The object of advancing between calls is to load the several junctor groups as evenly as a random arrangement will permit. If in the course of setting up a call the markers find the channels busy, they release the junctor cut-in relay and seize the new one. This continues until an idle channel is found or all junctor groups have been tested.

Each incoming connector or a pair of incoming connectors when seized, grounds two individual leads to the marker grounding a pair of armatures to the (JG) relays. One of these leads is used to ground punchings "JG" for operating the junctor cut-in relay in the line choice as shown on Fig. 3. The other is used for grounding "JP" punchings used to operate junctor pattern relays as indicated on Fig. 5.

JUNCTOR PATTERNS

A channel test involving a group of ten junctors or less is known as a subgroup test. Whenever a subgroup test must use less than ten junctors because of the junctor distribution it is necessary to make busy the positions corresponding to junctors not usable since the marker is arranged to always test ten junctors. This function is performed by the pattern relayd designated (JPN) and (JP0) to (JP8) as indicated on Fig. 7. Whenever a pattern relay is required for a subgroup test of less than ten junctors, it is also necessary to furnish relay (JPN) for the subgroups having the normal junctor pattern of ten junctors. The connections for windings and contacts of the pattern relays are shown in cross-connection charts for the various sizes of installation.

The action of the (RT-) relays results in the operation, of one of the (JGA) to (JGD) relays to determine which subgroup of junctors available shall be tested first on a particular call. As shown on Fig. 7 the (JG) relay may be cross connected to (JPN) in which case all test leads for the subgroup of junctors will be connected to the channel test relays of the marker.

The sample case illustrated on Fig. 7 chose pattern relays used to blank out certain junctors when relay (JGD) is operated. When this relay is operated, ground from the incoming connector through the (JGD) relay is cross connected to operate a pattern relay (JP0) to (JP9). With a (JP-) relay operated the test leads of usable junctors are cut through to the channel test relays while those blanked are connected to ground at the (JP-) relay contacts.

Since the junctors blanked will not be the same for different incoming groups, a different pattern relay is operated depending on which incoming group contains the calling incoming trunk.

Relays (LCA) and (LCB) shown on Fig. 7 are furnished when required when the junctor pattern for a particular incoming group varies on a subgroup test depending on the line choice which is called.

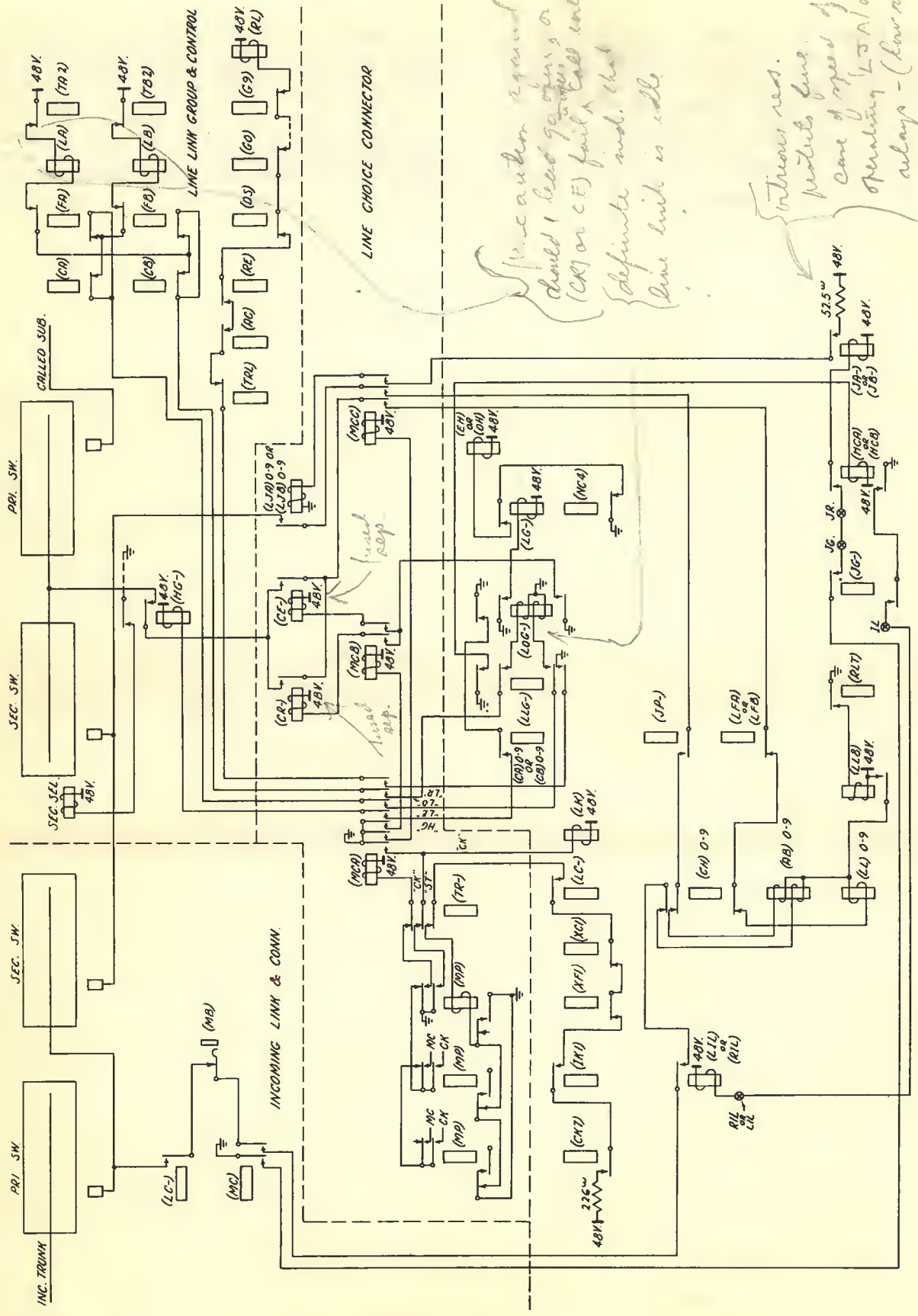


Fig. 1 - Terminating Marker - Seizing Line Choice Connector and Line Link Group and Control, also Channel Test

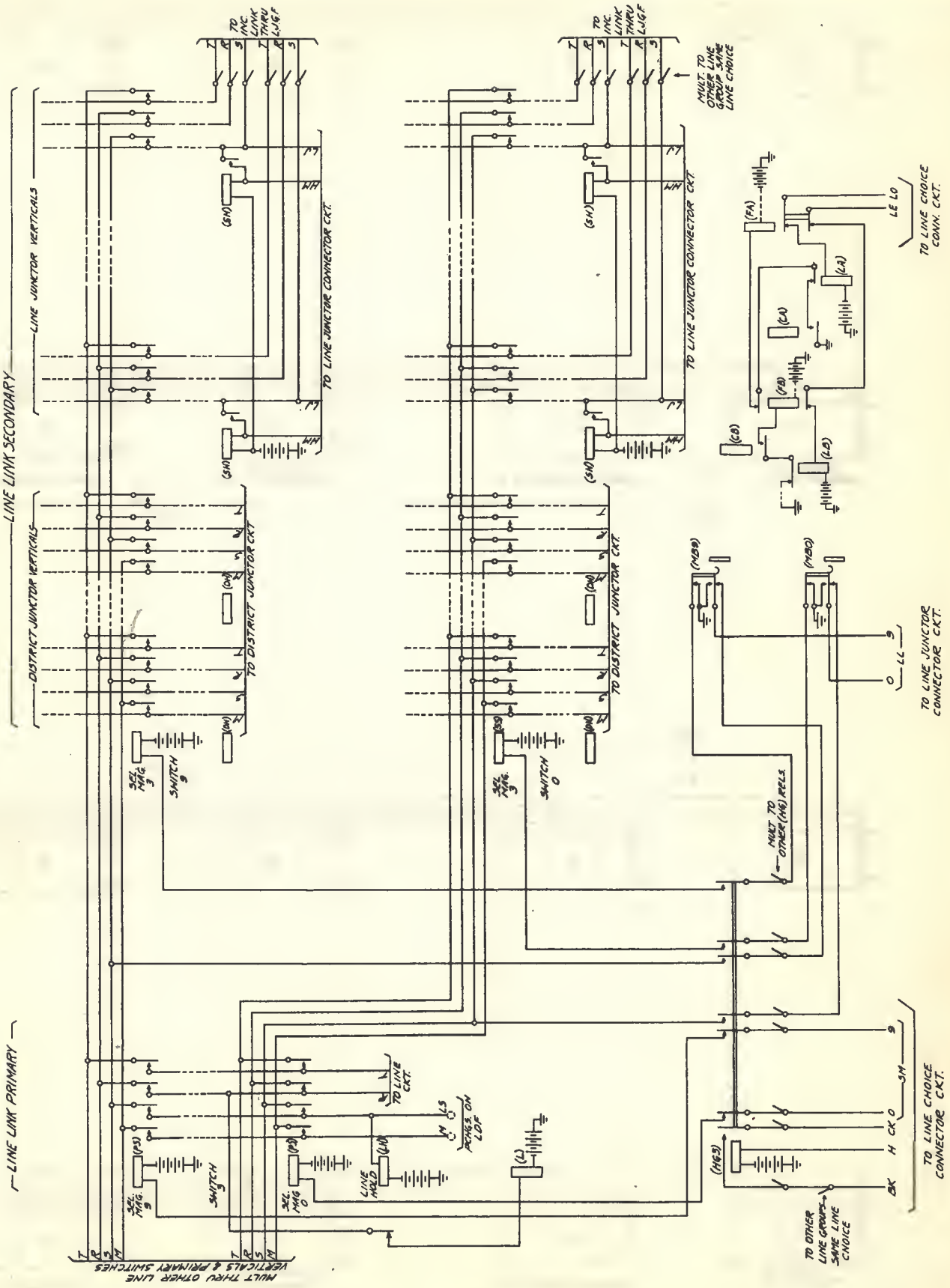


Fig. 2 - Line Link and Group Control Circuit - Terminating Call

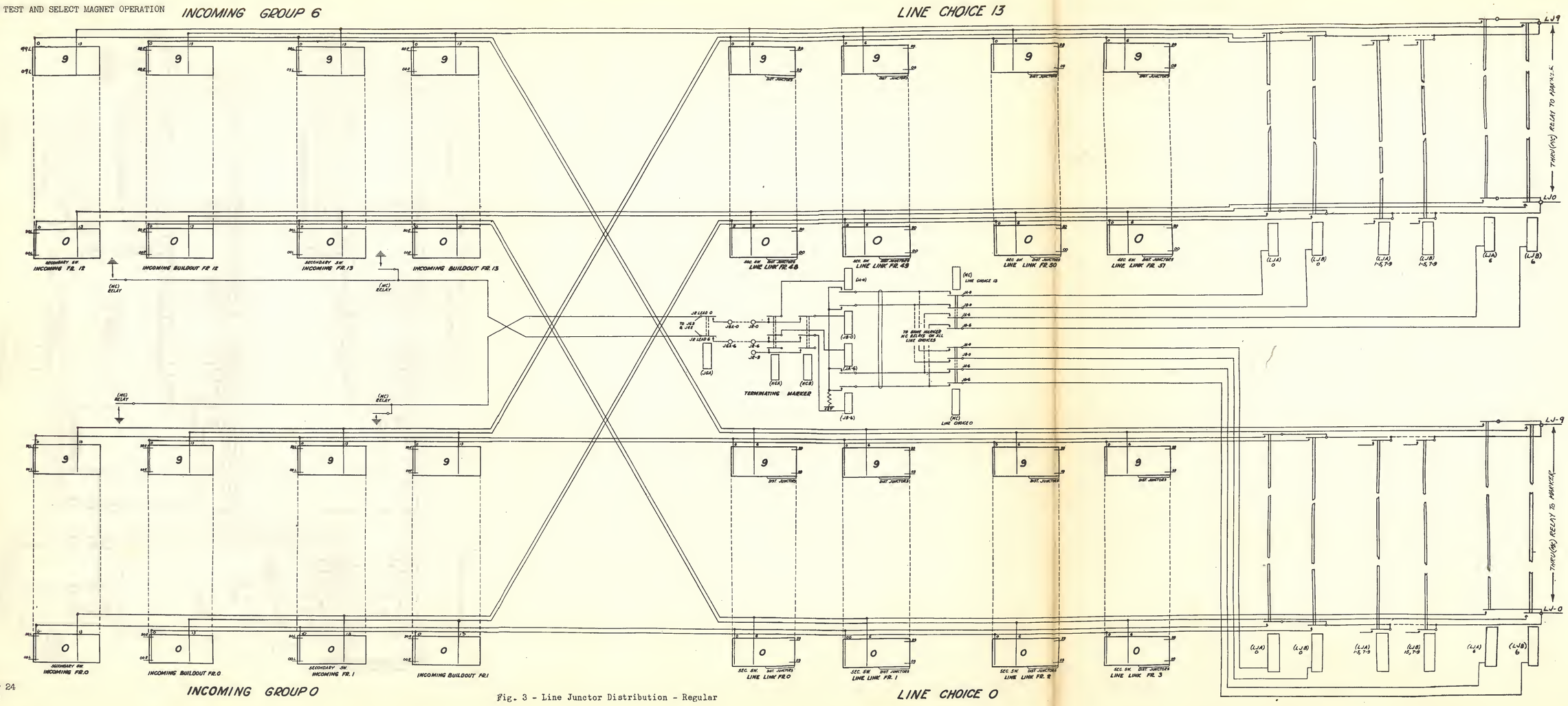


Fig. 3 - Line Junctor Distribution - Regular

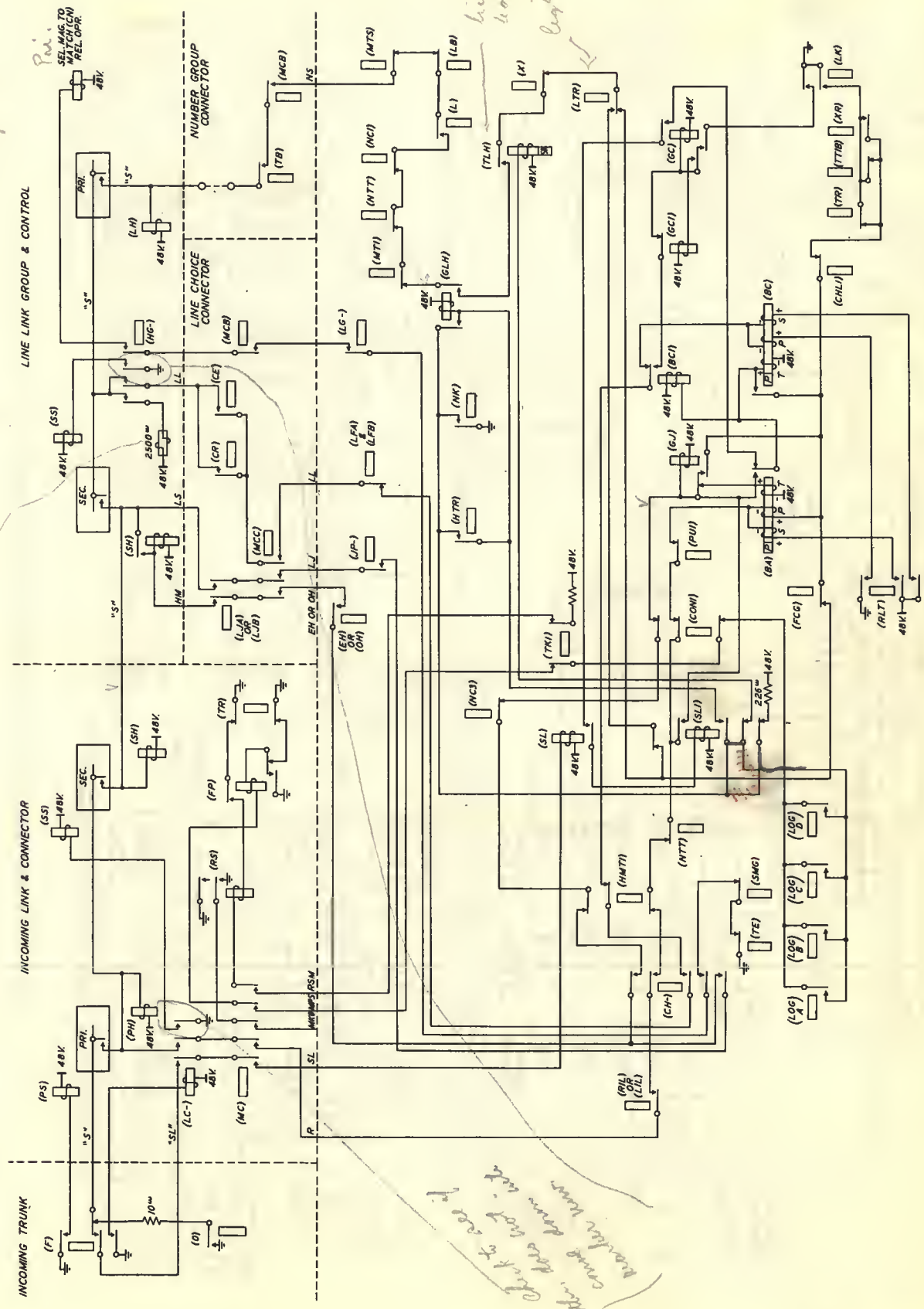


Fig. 4 - Terminating Marker - Operation of Channel, Select, and Hold Magnets and Check for False Grounds

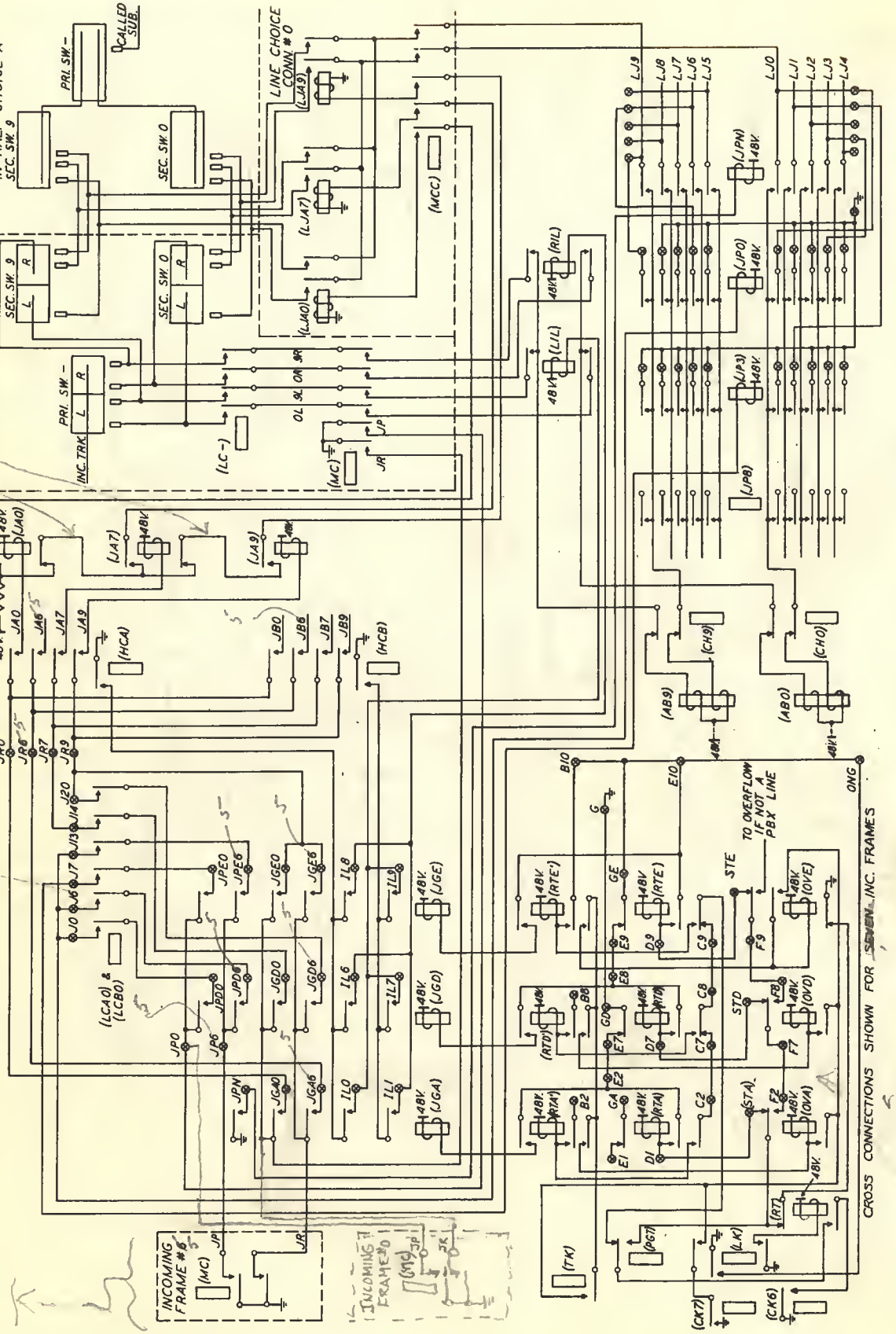


Fig. 5 - Terminating Marker - Selection of Line Junctor Group

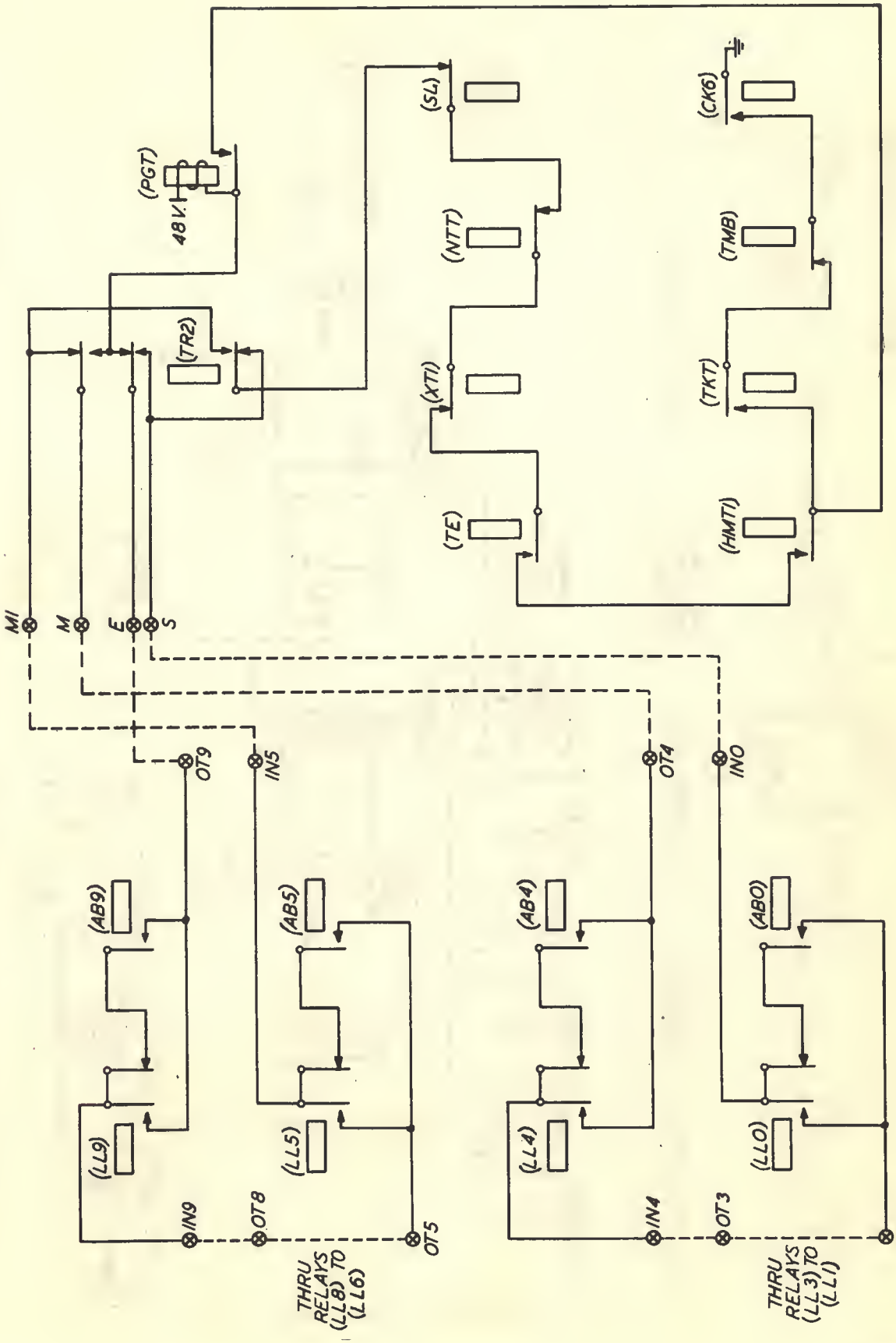


Fig. 5A - Terminating Marker - Operation of (PGT) Relay

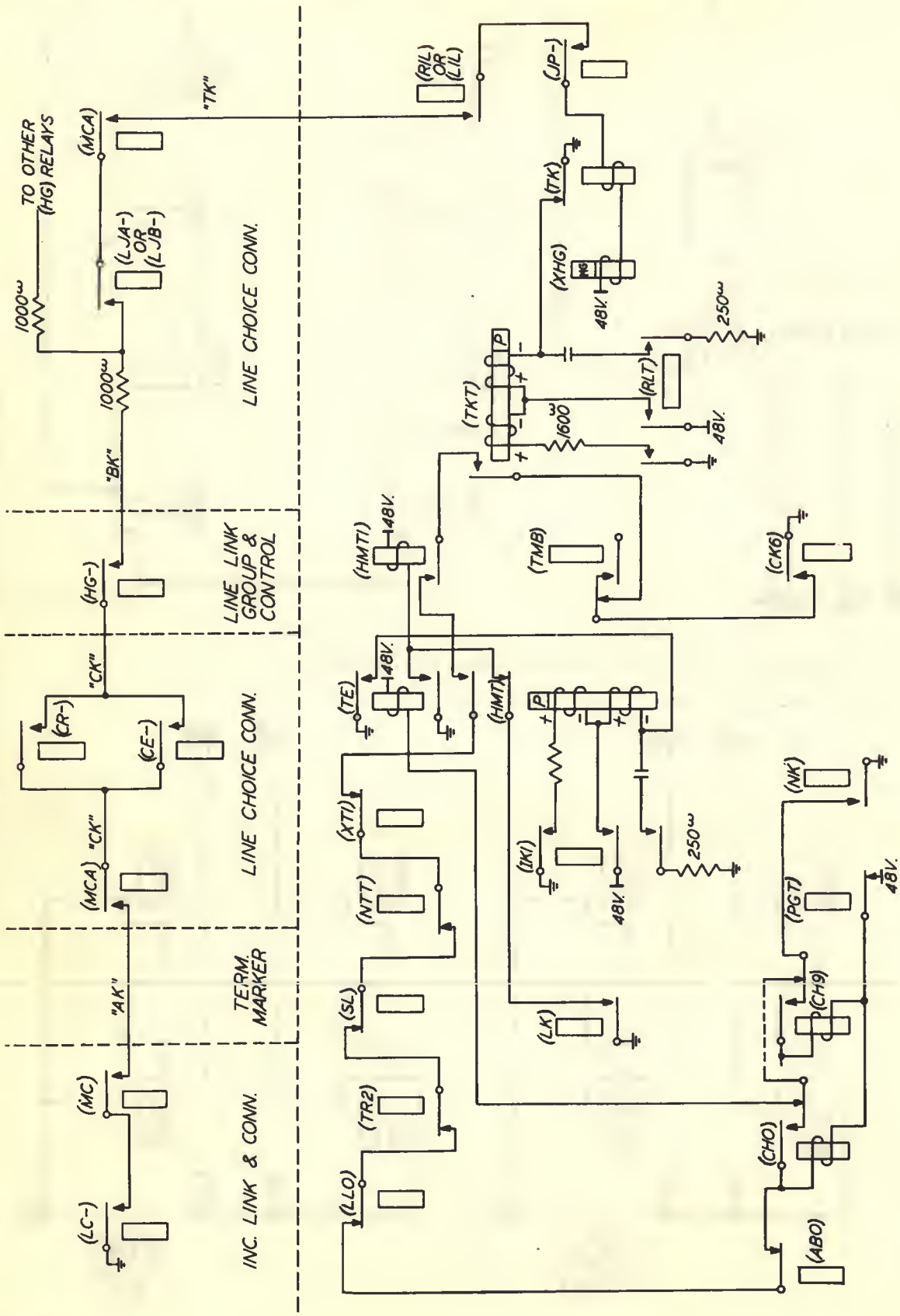


Fig. 6 - Terminating Marker - Check Lead for Operating (TK) Relay, Also Operation of (CH-) Relay

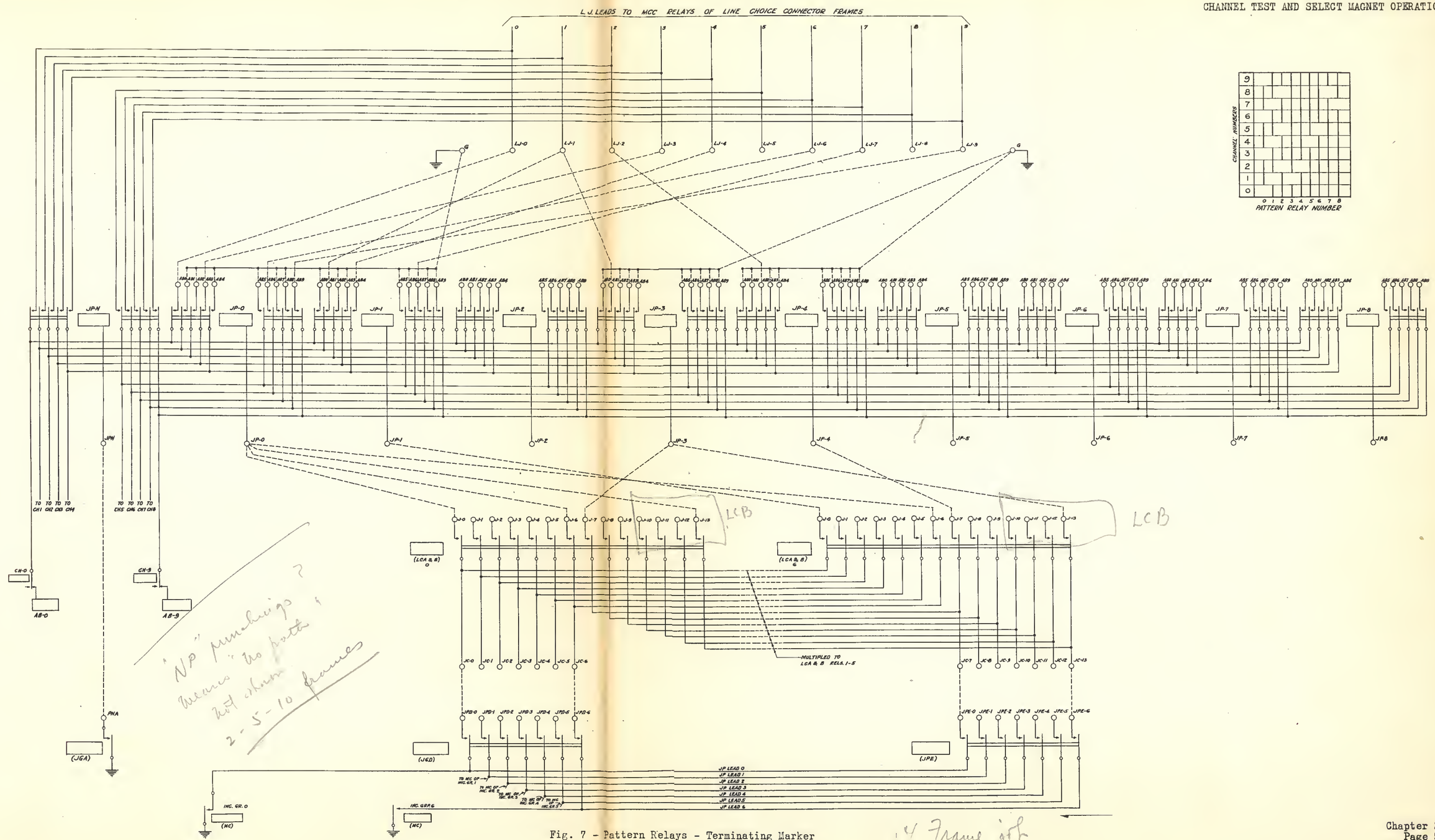


Fig. 7 - Pattern Relays - Terminating Marker

CHAPTER 25 - LINE CONTINUITY TEST, RINGING THE CALLED SUBSCRIBER, AND DISCONNECT OF TERMINATING MARKER AND SENDER ALSO INTERCEPT AND SLEEVE GUARD

After the operation of the line holding magnet, the tip and ring of the line are cut through into the marker for continuity and ground tests. The continuity test is made first and is followed by a check of the ringing control relays of the incoming, after which a ground test and double connection test of the line is made. These tests will be described in the order in which they are made by the marker.

LINE CONTINUITY TEST

The line continuity test illustrated on Fig. 1 is performed by condenser (A),tube (A), relays (CON), (CON1), (CON2), (CON3) and associated apparatus. Relay (CON) has two primary functions as follows:

To test for cross point continuity on the tip or ring conductor depending upon which the test is applied to.

To inform the marker that all the holding magnets have been operated.

One side of the subscriber line is connected to ground at the (IK1) relay and the other is connected in series with the (A) condenser and the secondary windings of the (CON) transformer which steps up the ringing voltage. The control elements of the vacuum tube, (terminals 1 and 4) one of which is in series with 200,000 ohms, are connected one on either side of condenser (A). The anode (plate) circuit is connected in series with relays (CON) and (CON3) to 110 volts positive battery. The primary circuit of transformer (CON) is not closed until relay (NK1) operates to reduce the drain on the ringing supply. The No. 1 terminal of the ionic tube is grounded by the (CON1) relay after the tube (A) has operated. Without this ground a sputter condition might result which would increase the variation in breakdown voltage and shorten the life of the tube. When the (GLH) relay operates the (GLH1) relay is operated. The (GLH) relay connects the "RT" lead to ground on the contact of relay (GLH1). During the operating time of relay (GLH1) this lead is grounded to discharge the "RT-TT" lead capacity before connecting the ionic tube for the continuity test. When relay (GLH1) operates it connects the "RT" lead to the ionic tube circuit for individual, PBX, and ring party lines and the "TT" lead for tip party lines. The other side of the line is grounded at relay (IK1). These leads are closed to the tip and ring of the line through the incoming trunk (F) relay and the incoming link and line link switches.

The closure of the circuit from the (A) condenser to the line causes a part of the voltage of the (CON) transformer to appear across this condenser. If the voltage drop is caused only by capacity and leak of the switches and associated cabling, it is less than the breakdown voltage of the tube. When the line holding magnet operates, adding the capacity and leak resistance of the line, the voltage drop across condenser (A), as measured by the control elements of tube (A), is sufficient to cause the control gap of the tube to break down and the anode circuit becomes effective. Current flow in the anode (plate) circuit operates relays (CON) and (CON3). Relay (CON) causes relays (CON1) and (CON2) to operate and lock. Relay (CON3) opens the continuity test circuit to prevent bell tapping and connects battery to the line to charge the line capacity so that the surge, which occurs when relay (GT) is later connected to the line, will be reduced.

The (CT) jack on the trouble indicator frame is provided to cancel this feature and other line tests. Failure of the (CON) relay to operate will often be due to line troubles in the outside plant equipment such as a cut cable. The (CT) jack is provided to prevent a large number of trouble indicator records in such cases.

RINGING CONTROL

There are four relays in the incoming trunk circuit which may be set in combinations by the marker for ringing and tone control as shown on Fig. 2. These relays are (RC) for ringing control, (RV) for reversing the ringing from ring to tip, (RP) for use with 4 party lines for changing the type of ringing current, and (TC) for tone control and cancelling supervision. When used for tone control, that is, on busy back and overflow calls, (TC) is used in combination with other relays. The operation of the (RC) relay in the incoming trunk places ringing current on the tip or ring of the called line through the winding of the (R) relay. The purpose of the (R) relay is to operate as soon as the called subscriber answers to trip the ringing

When the triple-wound (LC-) relay operated as described in Chapter 23 it also operated one of relays (RF), (TF) or (HF) in accordance with the cross connection of the "NF" lead for the called line. Relay (RC) in the terminating marker operates, on a normal call, through the contacts of the (HF) or (RF) relays to ground as shown on Fig. 2. Relay (RV) operates through the front contact of relay (TF) and back contacts of relays (HF) and (RF) in series. Relay (TC) operates from relays (FL), (BB) or (OF).

Relay (RC) grounds lead "RC" to the incoming connector for the purpose of operating incoming trunk relay (RC) and also operates relay (RC1) for checking purposes. Likewise, relays (RV), (RP), and (TC) ground similarly designated leads to the incoming to operate similarly designated incoming trunk relays and also relays (RV1), (RP1), and (TC1) respectively, in the marker for checking purposes. On a tip party call, relay (RC) is operated from ground through the contacts of relay (RV).

Relays (RP) and (RP1) in the marker are furnished only when 4 party ringing is required. When furnished, the (RP) relay is operated by ground from relay (IK) through the operated (H5') relay. Numerically, this means that the second 500 numbers in every thousand are arranged to operate the incoming (RP) relay while the first 500 numbers of every thousand will not operate this relay. Stations whose numbers are in the second 500 of every thousand will be rung with the type of ringing current provided by the incoming trunk with its (RP) relay operated.

CHECKING RINGING CONTROL RELAYS

The ringing relays in the incoming are operated in parallel with correspondingly designated check relays in the marker, namely, (RC1), (RV1), (RP1), where the (RP) relay is furnished, and (TC1) as illustrated on Fig. 2. On a regular call when one of these relays is held operated by ground from the incoming trunk, the correspondingly designated (RC), (RV), (RP) or (TC) relay in the marker should match and close the circuit from ground on the contact of relay (CON1) to operate relays (GT1) and (GT2) for the purpose of cutting off the continuity test and applying the ground test.

On an individual or ring party line the only one of these four relays operated is the (RC) together with its associated (RC1) relay. The (GT1) and (GT2) relay operating circuit is traced as follows on Fig. 3. Ground on the front contact of relay (CON2), front contact of (RC), back contact of (BB), front contact of (RC1), back contact of (RV) and back contacts of (RV), (TF), (RV1), (TC), (OF), (BB), (FL), and (TC1) to the windings of relays (GT1) and (GT2). Relays (GT1) and (GT2) operate to ground on relay (CON1).

Should a false ground be found on any of the leads not supposed to be grounded for the particular call, the above circuit will not close because of false operation of one of the check relays and the marker will time out. Likewise, should an incoming ringing relay fail to operate or lock, the corresponding relay in the marker will be normal and the checking chain will test open.

In checking through the front contacts of relays (RC) and (RC1), relay (BB) is checked normal since the (RC) and (RC1) relays are not expected to operate on busy back calls. This circuit, therefore, checks for false operation of relay (BB) on non-busy back calls and for false operations of (RC) on busy back calls.

Those calls which operate the (RP) relay check the front contacts of relay (H5) and calls which do not operate the (RP) relay check the back contact of relay (H5) to insure that the ringing corresponds with the number set up.

The checking circuit on tip party calls goes through the front contact of relay (RV), the front contact of relay (TF) and the front contact of relay (RV1) and on other calls through the back contacts of these three relays.

GROUND TEST AND DOUBLE CONNECTION TEST - NON-COIN LINES

Assuming that relay (GT2) operates satisfactorily on the previous test, it locks and removes the operating circuit for relay (GT) as shown on Fig. 1. The operation of relay (CON2), described above under line continuity test, connects the tip and ring of the called line to relay (GT) for the purpose of testing for ground.

The purpose of the ground test is as follows:

To detect 2 party lines which have become grounded and might give a false party line indication which would result in a false charge on originating calls.

To detect double connections, which would cause the supervisory ground to hold relay (GT).

To detect crosses between tip and message register leads.

Relay (GT) is operated by off-normal ground through a 3200 ohm resistance when the number group connector is seized and it closes ground to the "FC" lead to operate the incoming (F) relay when the incoming connector is seized. The operation of relay (GT2) removes the operating ground from relay (GT) and leaves the (GT) relay connected to both tip and ring, this circuit having been closed by the operation of the (CON2) relay. If no ground is present in excess of the allowable lead, relay (GT) releases dropping the incoming (F) relay. Should there be a false ground, however, relays (GT) and (F) will remain operated and the marker will time out. This test is cancelled on second trial and by the insertion of a plug in the (CCT) jack of the trouble indicator frame, so that the call is set up in spite of the grounded tip. In view of the fact that this cancellation eliminates a double connection test, the (CCT) feature should be used with due regard for this fact.

There are several legitimate line conditions which may hold the (GT) relay and result in trouble indicator records.

(a) A 2 party message rate line with the receiver off the hook will place a ground on the tip and if selected in this condition with the control circuit occupied so that the line cannot originate a call, the marker will time out and make a second

trial. In between the first and second trials, however, the line will usually be successful in seizing a control circuit and will, therefore, cause the terminating marker to return a busy indication. Should it not succeed in connecting to the control circuit the marker will disregard the tip ground on the second trial.

(b) PBX trunks which originate calls by grounding a line also react like 2 party lines. If the terminating marker has seized such a line and obtains the control circuit before the line relay has seized the control circuit, the marker will time out and a second trial will be made. If the line is successful in originating a call between first and second trials the second trial marker will find the line busy, otherwise it will cause the call to be terminated to the line with a short circuit on it.

MARKER RELEASE ON A REGULAR CALL

The operation of relay (GT2) left relay (GT) connected to the line and if there was no ground on either side of the line relay (GT) released. The release of relay (GT) removes ground from lead "FC" and relay (F) in the incoming trunk releases. On the second trials on non-coin lines the circuit to relay (GT) is held open at relay (TR2) and relay (GT) releases regardless of the condition on the line.

The release of relay (F) in the incoming results in the following operations as shown on Fig. 4.

It releases relay (LC) in the incoming connector and the incoming class relays in the marker.

It places a 10 ohm ground on the sleeve to hold the incoming and line switch hold magnets.

It removes ground from lead "SL" to the incoming connector which causes the marker (SL) relay to release followed by relay (SL1).

The release of relay (SL1) removes ground from the line sleeve which is the ground that was holding the connection prior to the release of the incoming (F) relay. The release time of relays (SL) plus (SL1), therefore, covers the releasing time of the incoming (F) relay and insures that it has settled down and reliably closed a holding ground for the train of holding magnets.

The release of relay (S1) grounds the "RL" lead to the sender over the following path as shown on Fig. 4, 10 ohm ground from the back contact of the incoming (F) relay through the sleeve contacts of the train of holding magnets, break contacts of relays (MT5) or (MT6), make contact of relay (L), break of relay (NTT), make of relay (GLH), break of relay (MT1), break of relay (X), break of relay (SL1), break of relay (XR), break of relay (X), make of relay (CK6) and make of relay (LLB). This ground operates the sender (RL) relay which causes the removal of start battery from the marker connector releasing the connector relays.

The release of the marker connector opens the register leads and lead "CKG", causing the release of the marker register relays, relays (CK6), (CK7), (CK8), (CK4), and (CK5) and the translator relays. The release of relay (CK6) removes start battery from the incoming connector circuit which also releases. Relay (CK6) opens the release lead to prevent an overlap in case the marker is immediately reseized. Relay (CK7) opens the start lead to the line choice and opens the twenty block relay operating circuit. Relays (CK6) and (CK7) also open a large number of off-normal ground leads. The release of the register relays followed by the release of the translator removes the battery to the number group connector.

TERMINATING SENDER RELEASE

When a connection has been established, or when the attempt has definitely failed, either relay (RL) or (TRL) is operated and locked to an off-normal ground, as shown on Fig. 5.

Relay (RL) operating breaks battery from the "ST" lead to release the marker connector. Relay (RL) also breaks the local ground connection which locks relay (ON1) and holds the link switches over lead "S", but these do not release at once because they are also held over lead "HLD" from the marker connector. When that releases relay (ON1) and the link switches also release and the sender is freed from its external connections. The reason for holding over the "HLD" lead is to prevent the breaking of current on the cross points of the register. When relay (ON1) releases, it is followed by relay (RA1) if that is operated, and then by relay (ON2). The register and all locked up relays release, and the sender is normal and ready for reuse.

Relay (TRL) operating breaks battery from the "ST" lead and breaks the local ground connection which locks relay (ON1) and holds the link switches over lead "S", just as relay (RL) would do. The marker connector is released, and in doing so breaks its ground from the "HLD" lead, so there is no longer any ground on the "S" lead or the primary winding of relay (ON1). The link switches release and the sender is freed from its external connections. If there is no plug in the (HLD) jack, relay (ON1) also releases and the sender restores to normal, but if there is a make busy plug in the (HLD) jack, relay (ON1) will hold on its secondary winding, the register and all locked up relays will hold and the sender will remain busy on the "SB" lead ground, until the plug is removed.

BUSY LINE

If an individual line has ground on its sleeve or if all terminal hunting line sleeves of a group are grounded, the marker will attempt to set the incoming for busy back.

In either case ground originally supplied by relay (TLT) through the numerical registers and the (S) and (HT) relays will operate relay (BB) as discussed in Chapter 23. Relay (BB) is slightly slow in operating to prevent a false busy back should an (HT) relay prove slower in operating than the interval allowed by relay (TLT).

Relay (BB) operates relays (TC) and (RV) which operate relays (TC1) and (RV1) locally and relays (TC) and (RV) in the incoming trunk as shown on Fig. 6

Relay (RV1) opens the operating circuit for the slow release relay (OR) which previously operated to off-normal ground. Relay (OR) is slow enough in releasing to permit the slowest (RC), (TC) or (RV) relay in any incoming to operate. Upon the release of the (OR) relay, the (SRL) relay operates and grounds the winding of relay (CON1). Relay (CON1) operates relays (GT) and (GT2) over the following path; back contact of relay (RC), front contact of relay (BB), back contact of relay (RC1), front contacts of relays (RV) and (RV1), contacts of relays (RP), (H5') and (RP1), front contact of relay (TC), front contacts of relays (BB) and (TC1) to the windings of relays (GT1) and (GT2). Relay (SRL) closes ground from its winding through its front contact, front contact of relays (RV1) and (GT2) to the release lead operating the sender (RL) relay and causing the release of the marker.

The (RV) and (TC) relays in the incoming provide a path for flashing the (T) relay at the rate of 60 interruptions per minute as a line busy signal. At the same time interrupted low tone from the (LBT) interrupter is connected through the contacts of the (RV) and (TC) relays and through the (A) condenser to the line as a line busy signal to the calling subscriber.

OVERFLOW

If all available channels are busy relay (PGT) operates relay (OF) through contacts of relays (OVA) to (OVE) if there are not exactly ten incoming frames or groups, or directly if there are exactly ten incoming frames or groups. This is illustrated on Fig. 7. Relays (OVA) to (OVE) operate through make contacts of the corresponding (RT') relays and relay (OF) operates through contacts of the operated (OV) relays and through relay (PGT). Relay (OF) locks to off-normal ground, opens in part the operating circuit for relay (OR) and operates relays (TC) and (RV), the latter in turn operating relay (RC).

Relays (RC1), (TC1) and (RV1) operate locally and relays (RC), (TC) and (RV) in the incoming operate from contacts of correspondingly designated marker relays. Relays (RV1) and (RC1) finally open the path for relay (OR), which is slow release to insure time to operate the incoming relays. The release of relay (OR) is followed by the operation of relays (SRL), (CON1), (CON2), (GT1) and (GT2), the operating path of the relays (GT1) and (GT2) being as follows: Ground from relay (CON1), make of relay (RC), break of relay (BB), make of relay (RC1), make contacts of relays (RV) and (RV1), make contacts of relays (TC), (OF) and (TC1) to the winding of relays (GT1) and (GT2) in parallel. The (GT2) relay closes the release lead to the (SRL) ground and operates the sender release relay which causes the marker to release.

The (RC), (RV), and (TC) relays in the incoming trunk provide a path for flashing the incoming trunk (T) relay at the rate of 120 interruptions per minute from the (OF) interrupter. On calls originating in panel or crossbar offices these relays will also connect interrupted low tone from the (OFT) interrupter through the (A) condenser to the line as a paths busy signal to the calling subscriber.

INTERCEPT

Terminating calls are routed to intercept operators in case of trouble on the line called, the line called being denied terminating service, or in case the number called is unassigned (a blank number). The methods of causing the marker to recycle and route the call to the proper group of intercept trunks is shown on Figs. 8, 9, 12, and 13.

SLEEVE GUARD

Since the marker does not operate the hold magnet of a line as soon as it is selected, it is possible that the called subscriber may start an originating call before the channel magnets have been operated for the terminating call. In this case it is the practice to give preference to the originating call. The sleeve guard feature shown on Fig. 10 is connected to the sleeve lead of the line selected and if it receives a ground indicating that an originating call has started, it causes the marker to recycle and attempt to set up the call again. This time the ground on the sleeve of the line will cause it to appear busy and the calling party will receive the busy signal and the originating call proceeds.

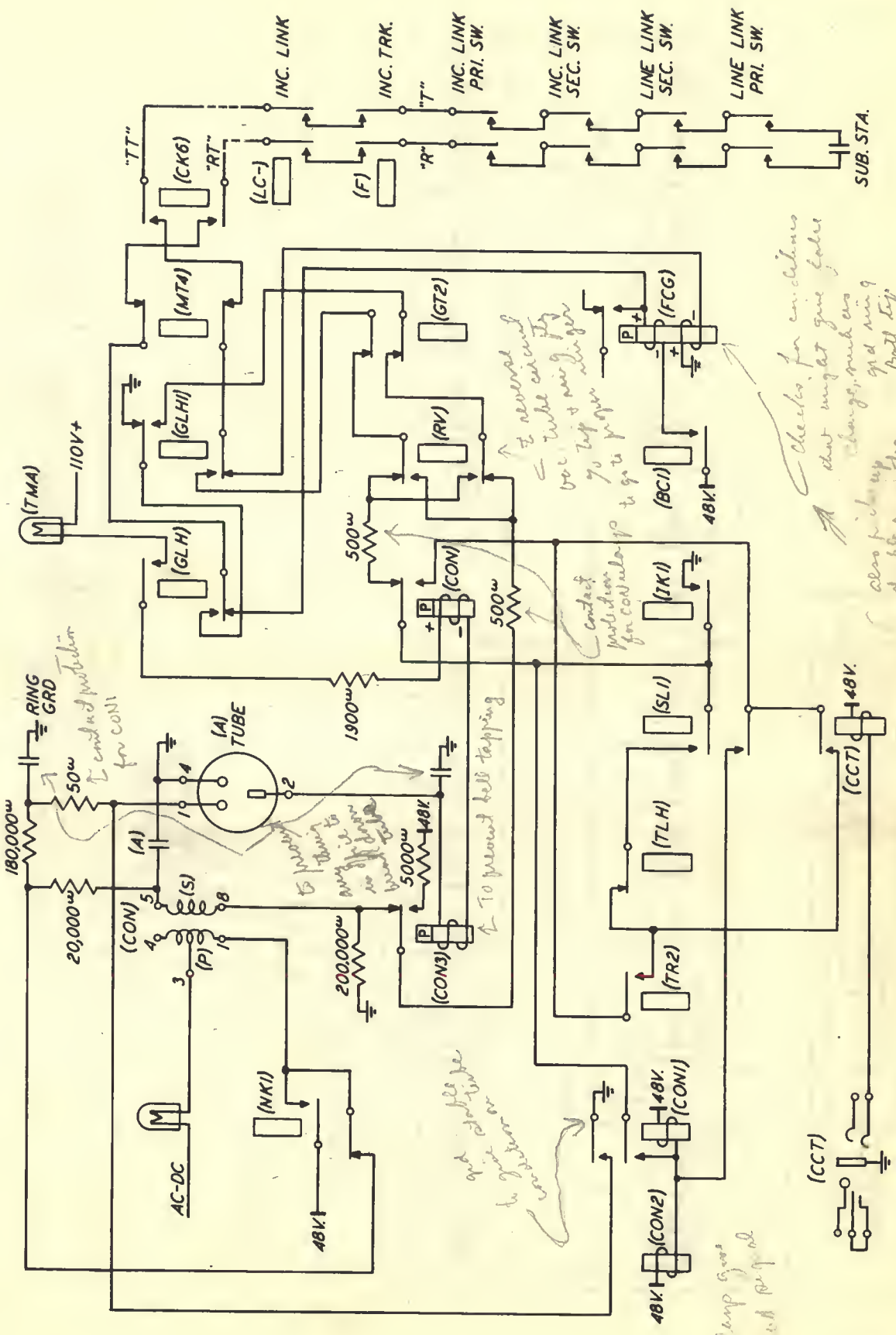


Fig. 1 - Terminating Marker - False Cross and Ground Test also Crosspoint Continuity Test

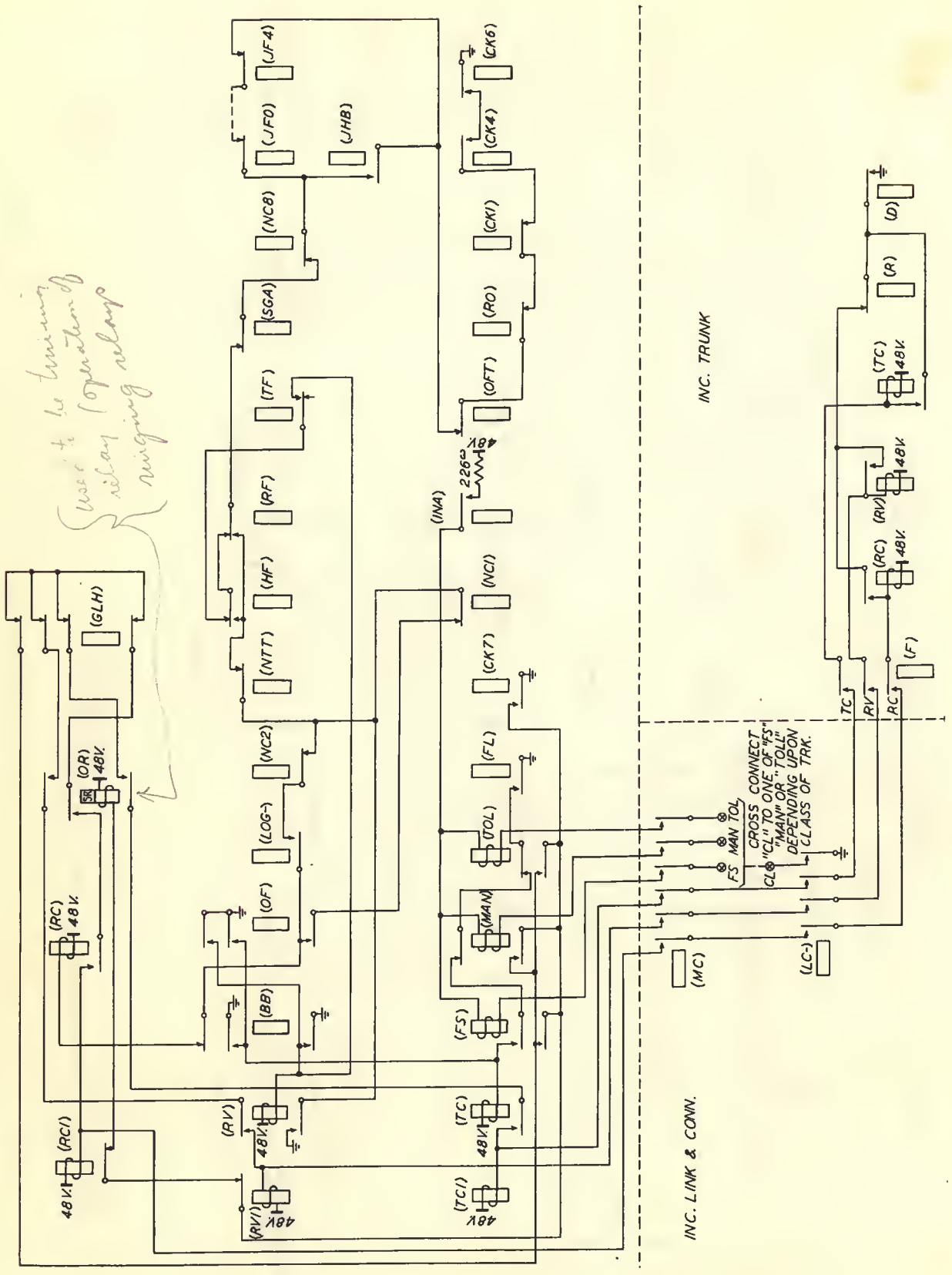


Fig. 2 - Terminating Marker - Ringing Control

CALL	TC	RV	RC
DIR., PBX & RING. PARTY			✓
TIP PARTY		✓	✓
BUSY BACK	✓	✓	
OVERFLOW	✓	✓	✓
FREE LINE	✓		✓
NUMBER CHECK O.K.		✓	✓
NUMBER CHECK FAILURE		✓	

Can never have a free line as a tip party

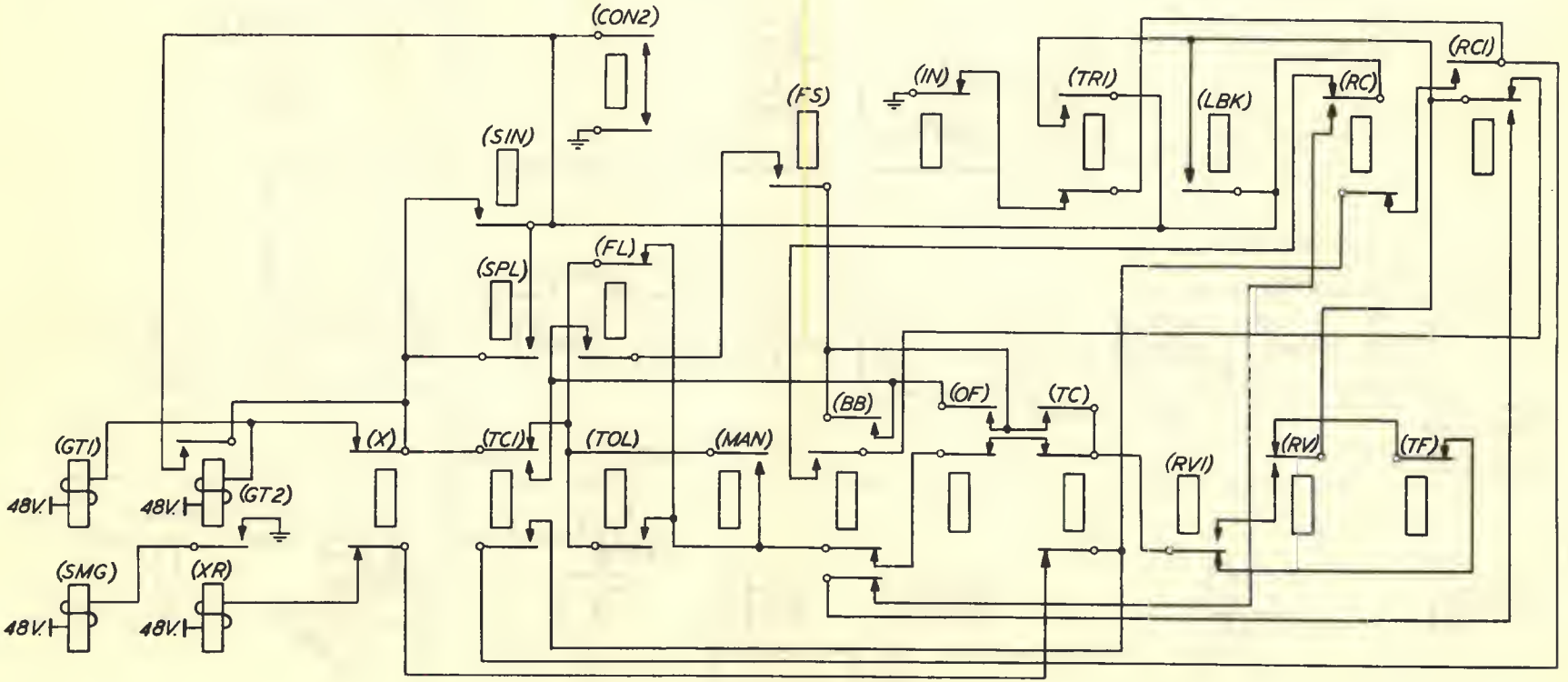


Fig. 3 - Terminating Marker - Operation of (GT1) and (GT2) Relays and Check of Ringing Control Relays

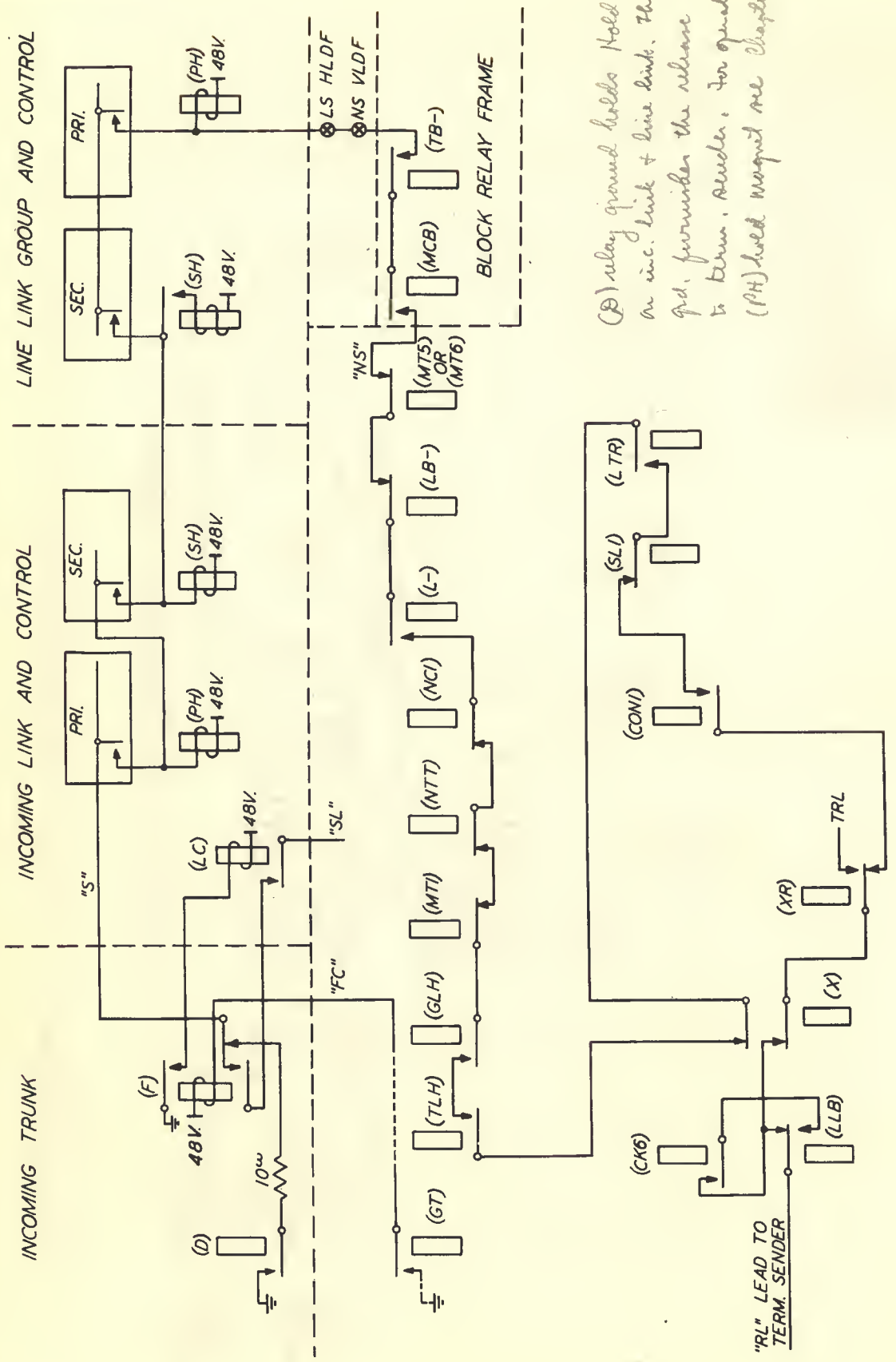


Fig. 4 - Terminating Marker - Marker Release on a Regular Call

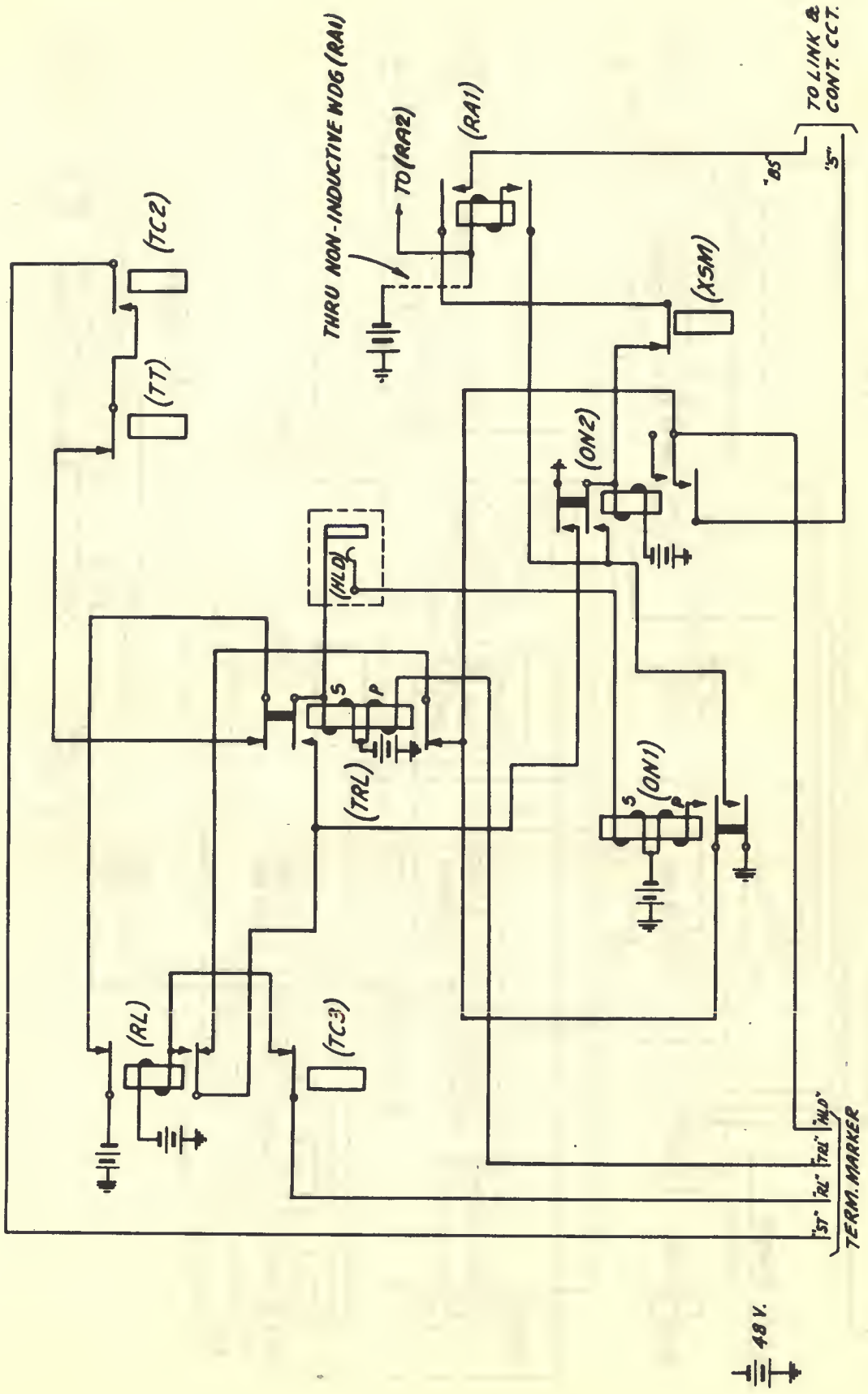


Fig. 5 - Terminating Sender Release

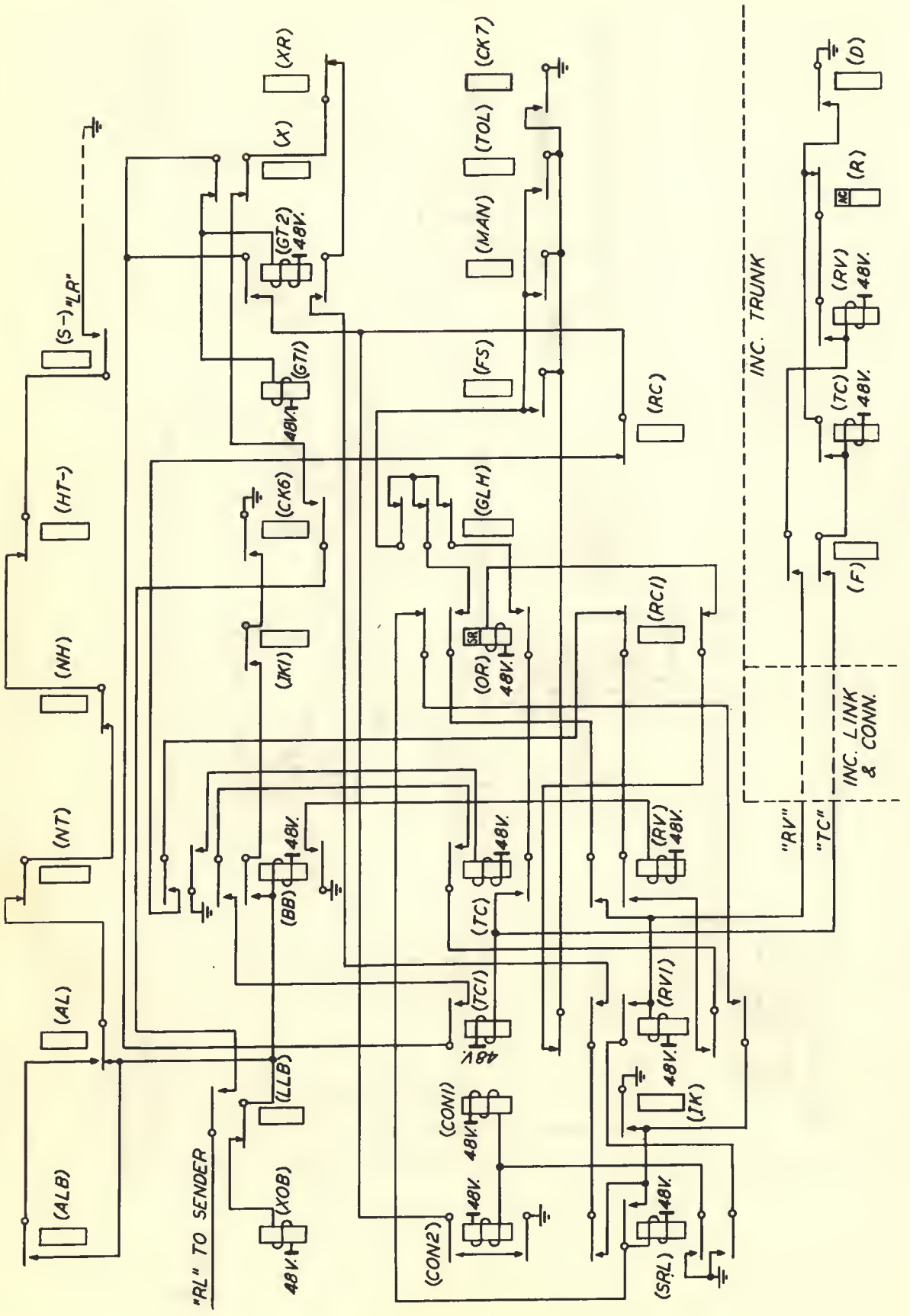


Fig. 6 - Terminating Marker - Busy Line

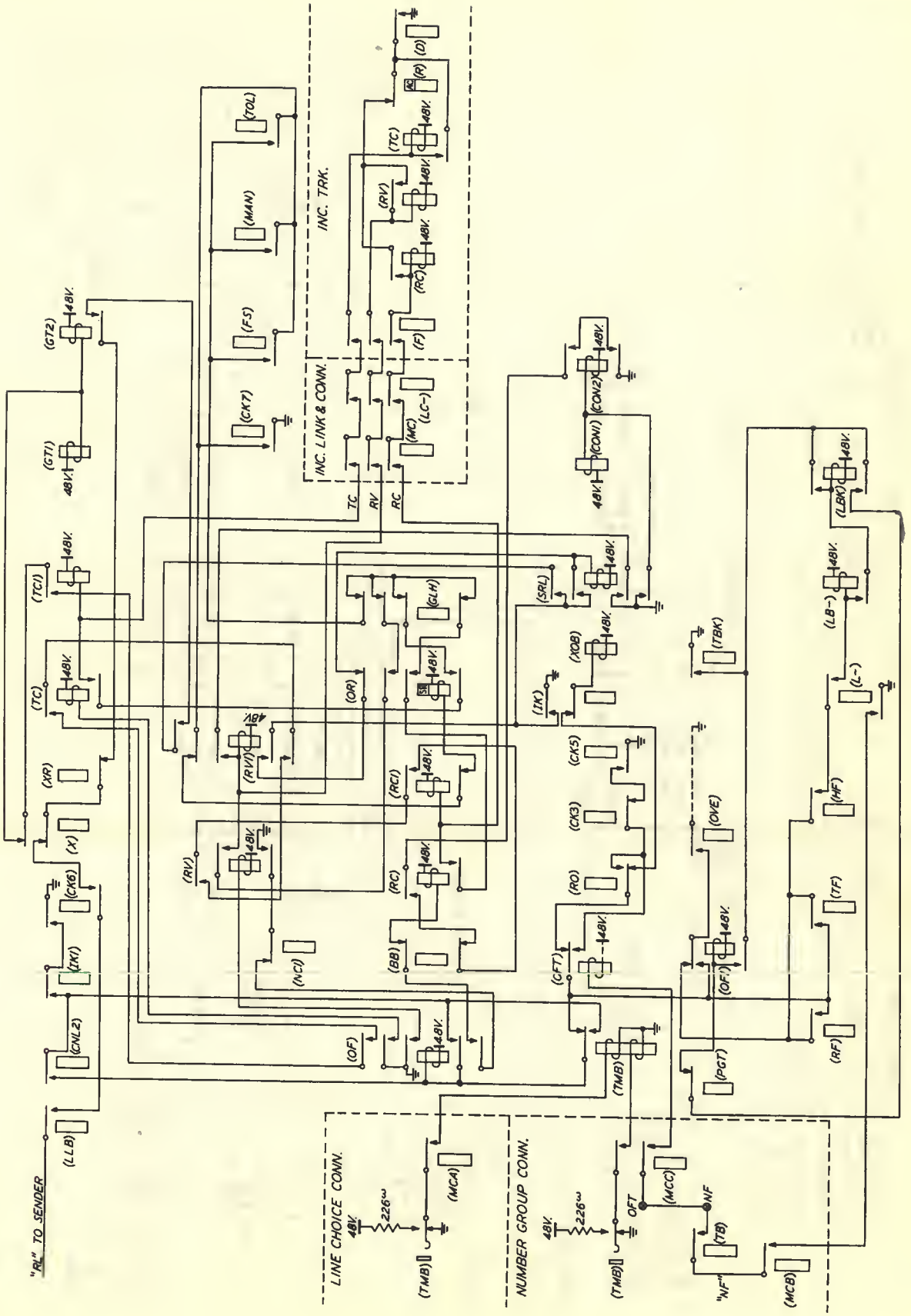


Fig. 7 - Terminating Marker - Overflow

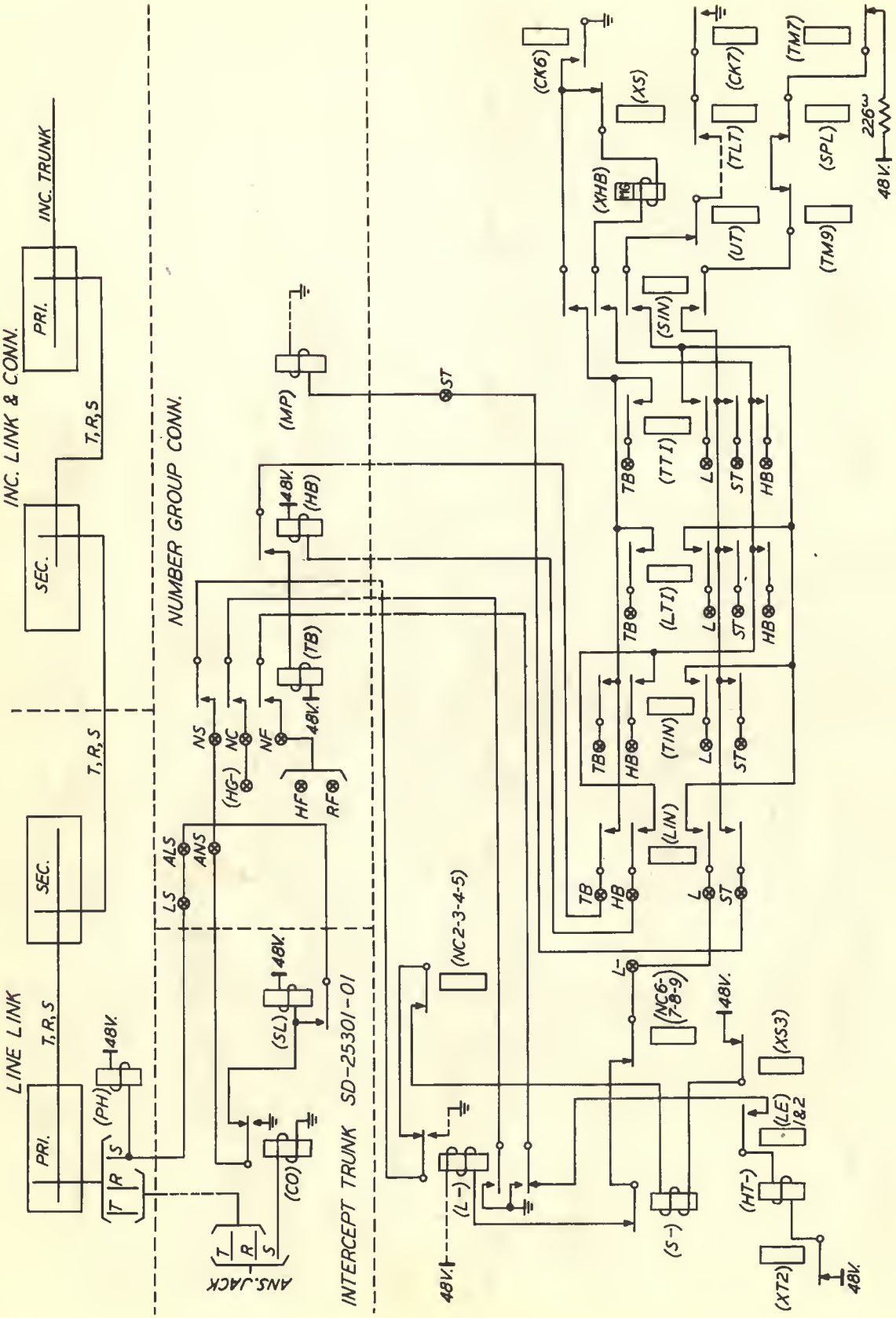


Fig. 8 - Terminating Marker - Intercepted Calls

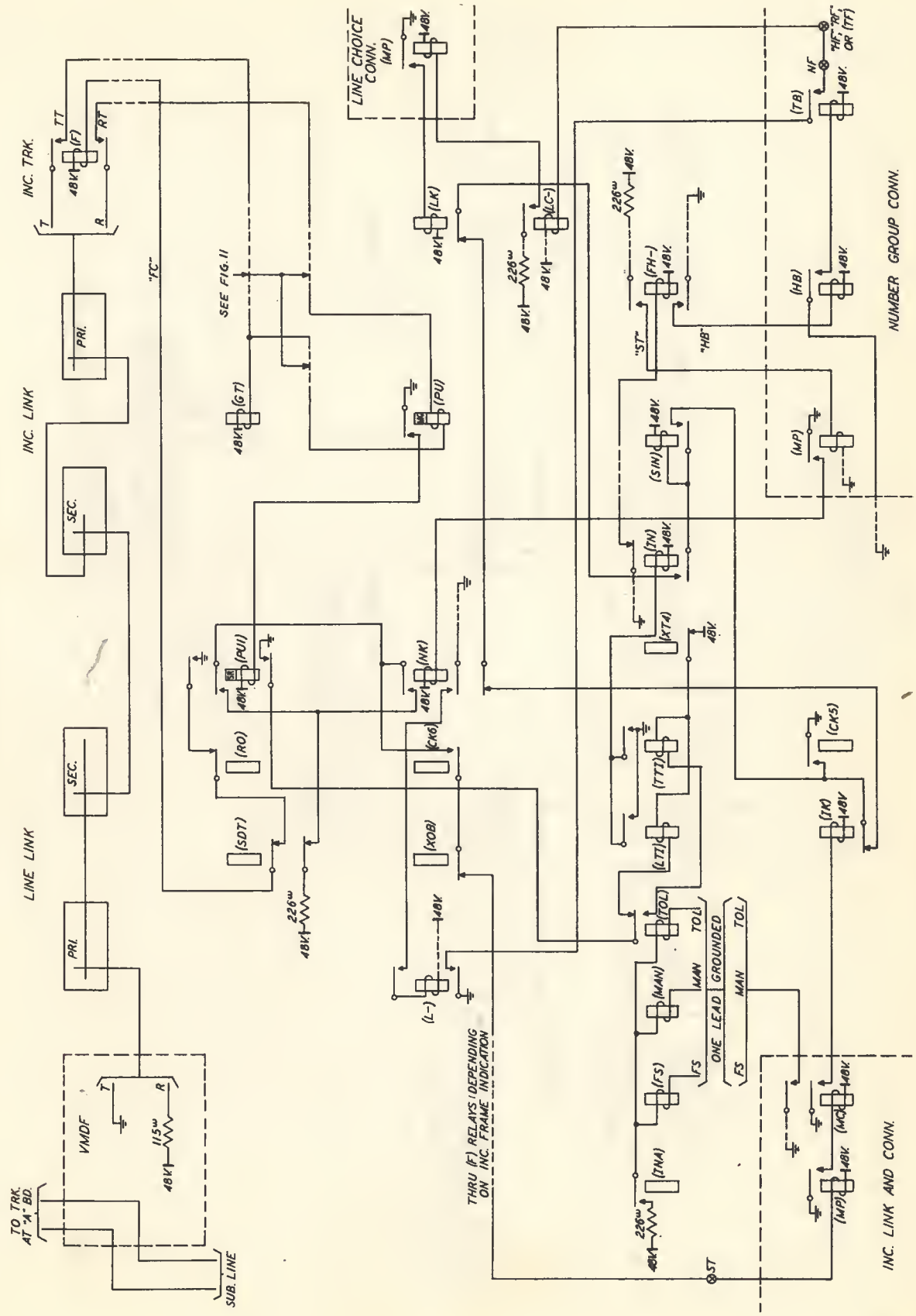


Fig. 9 - Terminating Marker - Trouble Intercept

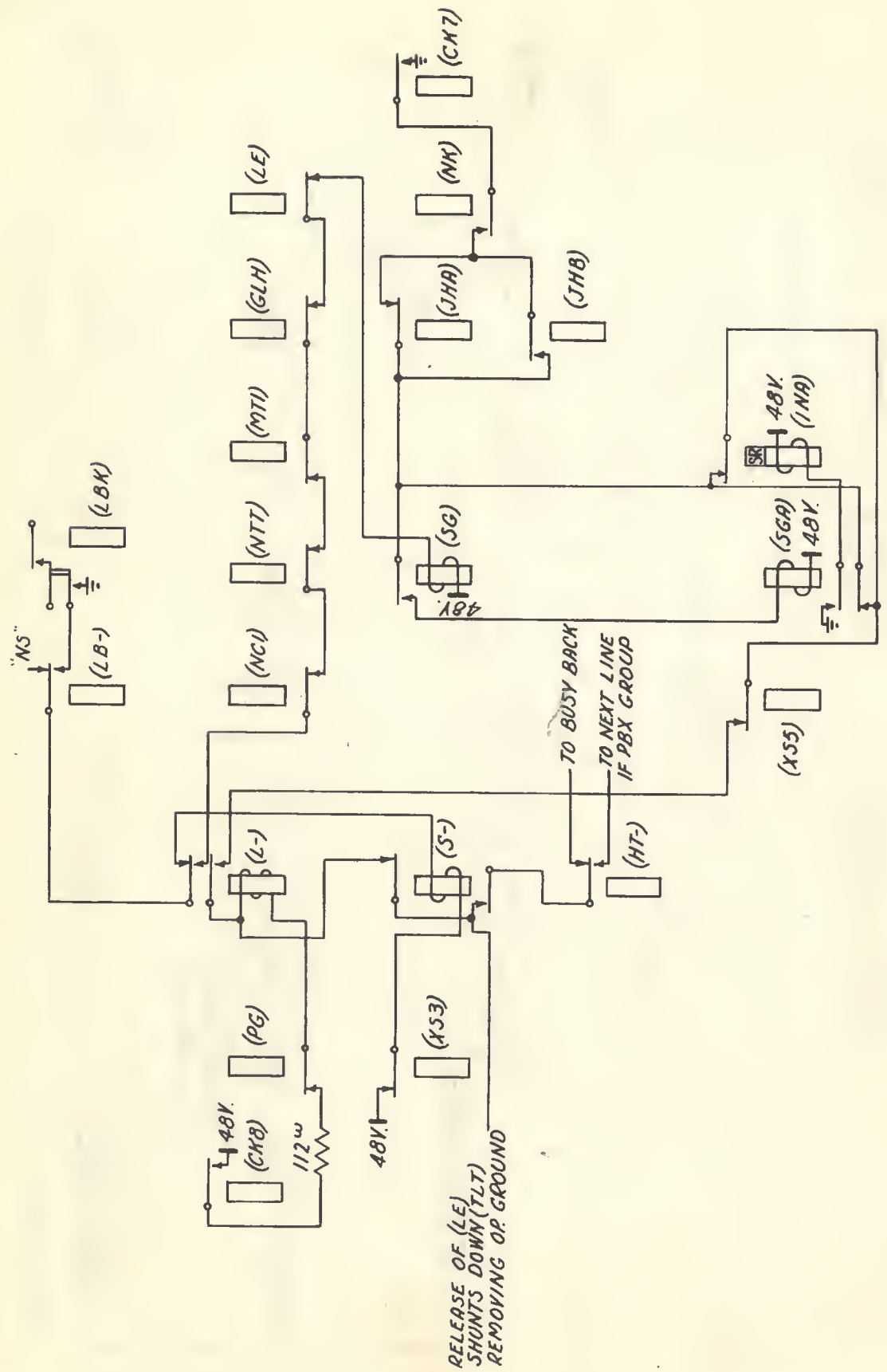


Fig. 10 - Terminating Marker - Sleeve Guard

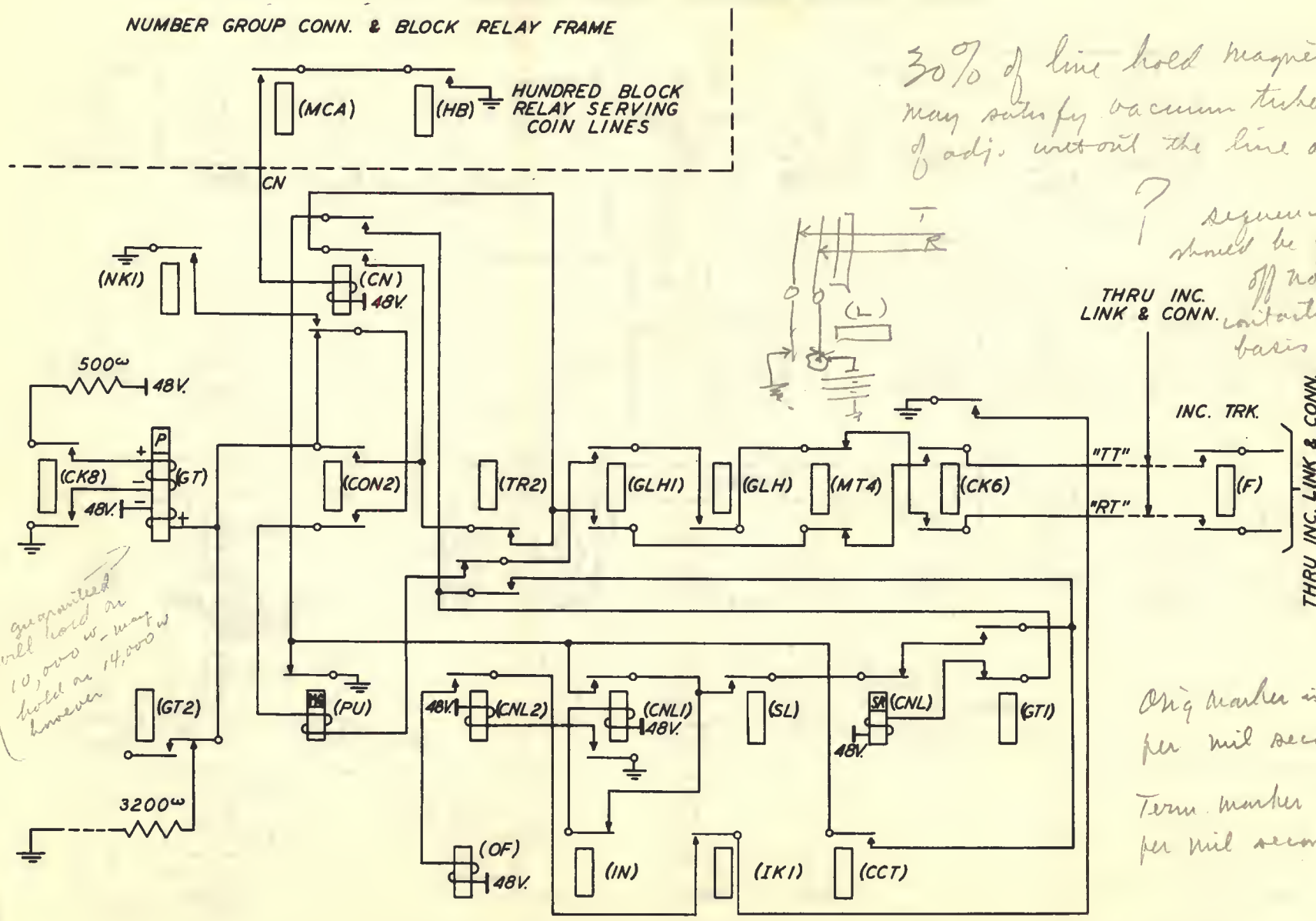


Fig. 11 - Terminating Marker - Ground and Double Connection Test - Non-Coin Lines also Test for Receiver off the Hook on Coin Lines

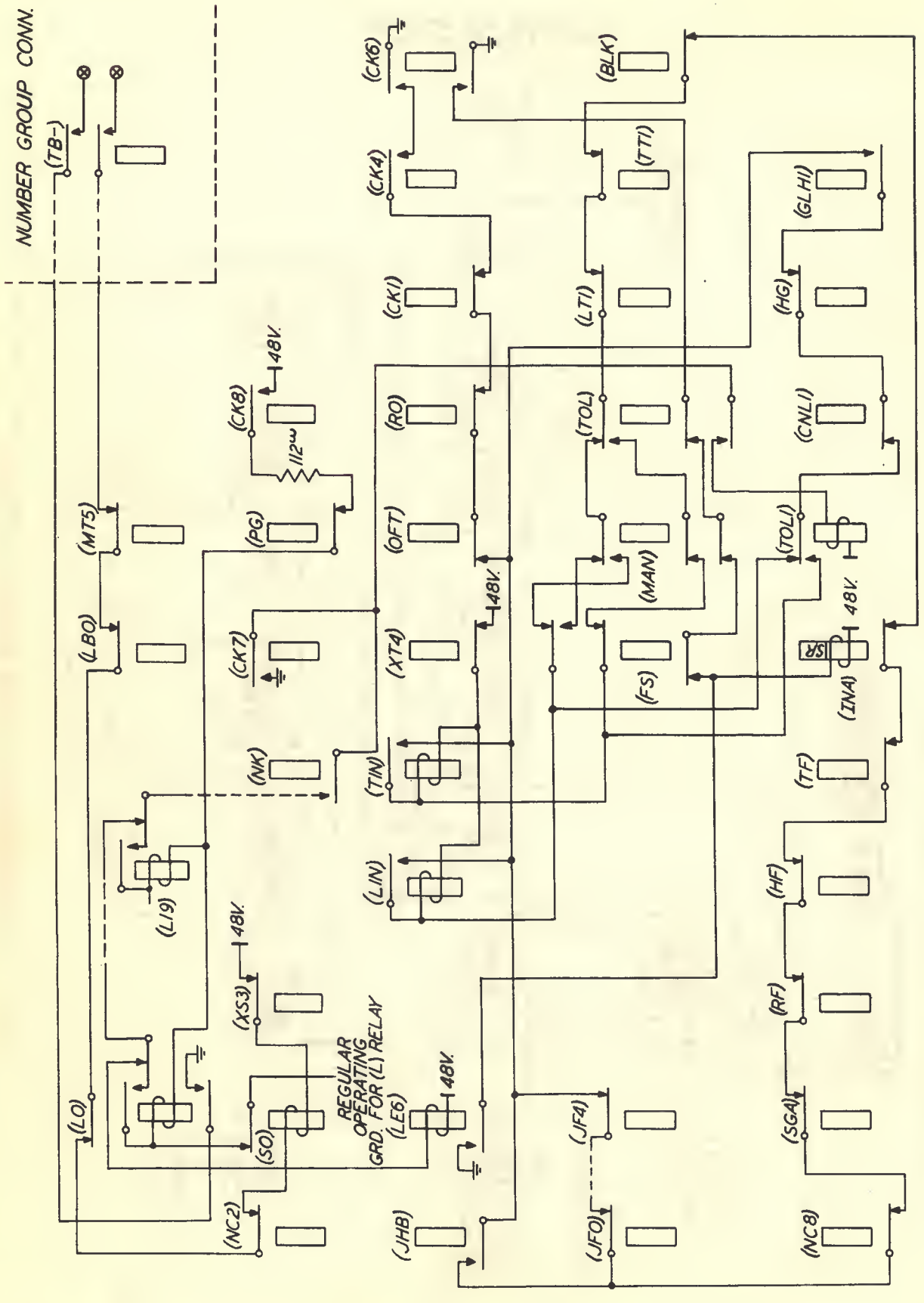


Fig. 12 - Terminating Marker - Unequipped Individual Numbers

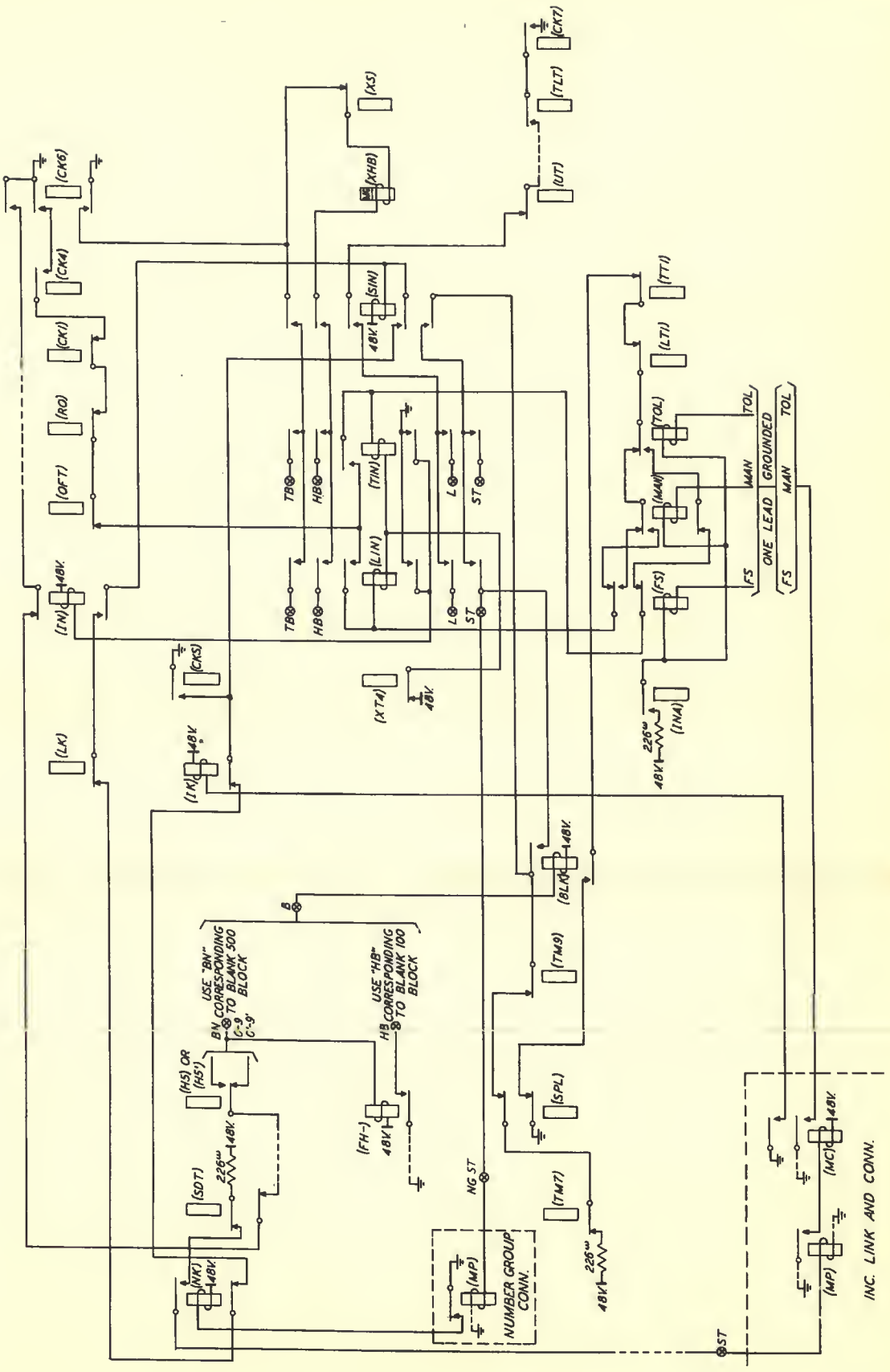


Fig. 13 - Terminating Marker - Unequipped Numbers in Blocks of 500 and 100

CHAPTER 26 - PCI CALLS

There are three classes of PCI calls, namely: PCI tandem ((CL2), (CL4) relays in the subscriber sender operated), PCI direct ((CL1), (CL2), (CL4) relays operated) and official code through PCI tandem ((CL2), (CL3), (CL4) relays operated).

When the sender is connected to the trunk to a PCI tandem office, trunk test is made as soon as dialing is completed. The subscriber sender waits for the trunk assignment with a trunk guard relay held operated in the fundamental circuit. The operated trunk guard relay informs the pulse generating circuit to prepare itself for the transmission of PCI pulses. After the trunk is assigned at the distant end, the trunk guard relay releases causing the transmission of PCI pulses to the call indicator office through the same compensating resistances which were used in the trunk test.

The sender now proceeds to transmit the office code according to the setting of the (A), (B), and (C) dial registers. Following the transmission of the office code on a tandem call, the sender transmits a possible five digits of the numerical code according to the setting of the stations (ST), thousands (TH), hundreds (H), tens (T), and units (U) on the dial register. In the case of a PCI direct (not through tandem) call, the numerical code only is transmitted in the same manner.

If the called number is under 10,000 the pulses are transmitted in the order named above with the party letter digit (ST) transmitted between the last office code digit (C) and the first digit of the numerical code (TH). If the called number is over 10,000 then the station (ST) digit (being a fifth numerical digit) is sent after the units digit (U) instead of before the thousands digit (TH). A digit zero is transmitted in place of a party letter or fifth numerical digit if no party letter or an impossible five digit number was dialed.

Following the last digit, the sender transmits a special signal consisting of a blank pulse, followed by a heavy positive pulse of extra length to move the panel selector circuits in a mechanical tandem office into the talking position.

PCI TRUNK TEST

The fundamental circuit is closed when relays (S6') and (F03) are operated as shown on Fig. 1. Relay (S6') operates upon the release of relay (DC) when the decoder establishes connection to a trunk if the call is skip office, relay (S6) having operated upon the operation of relay (DC), or upon the completion of distant office selections. Relay (F03) operates upon the release of relay (F02) and operation of relay (RC) which occur when the completion of dialing operates relay (STL).

Relay (TG) operates to battery from the distant end of the trunk but relay (OF) does not operate because of its polarity. With relay (TG) operated it operates relay (TG1) which in turn operates relay (TG2). The operation of relay (TG2) closes a circuit to operate relay (CI1) which locks until relay (AC1) operates after PCI pulses have been sent. Relay (CI2) operates to a make contact of relay (CI1). The (TG) relays hold operated until the trunk is assigned at the distant end, when they release to start PCI pulsing.

GENERATION OF PCI PULSES

The PCI pulsing circuit consists of start pulse (SP) relay, pulse generating (PG), (PG1), (PG2), and (PG3) relays, grounding (GR) relay, pulse tip (PT) and pulse ring (PR), relay (12) which supplements both leads "1" and "2" from the registered digits on the crossbar switch, relay (34) which supplements both leads "3" and "4" from the registered digits on the crossbar switch, and final pulse (FP) relay. The (12) and (34) relays are used to save contacts on the dial register switch (see Fig. 2).

Relay (PG) is a non-biased condenser-timed polarized relay. It cannot be said to operate or release, but it closes its front contact when energized in one direction by its primary winding, closes its back contact when energized in the other direction by its primary winding and remains on either contact or between the contacts when not energized. When current is first closed through the primary in either direction, its force is more than neutralized by an opposing current in its secondary winding, the source of which is the charge or discharge of the timing condenser. When the condenser has been charged or discharged, current ceases to flow in the secondary and the primary causes the armature to move from one contact to the other. The actual time of operation varies somewhat with variations in voltage, resistance and relay adjustment. It averages about .069 second per single operation.

When the (PG) relay closes its front contact, relays (CI1) and (SP) being operated, it grounds out the 300 ohm battery and so starts opposing currents in the two windings. At first the effect of the secondary winding is stronger and the front contact is held closed, but as the condenser discharges the current in the secondary dies down, until the effect of the primary becomes the stronger, when the relay breaks its front contact and closes its back contact. Now the battery through 300 ohms is not grounded out and currents start in the two windings in directions reversed from what they were before. At first the effect of the secondary winding is stronger and the back contact

is held closed, but as the condenser charges the current in the secondary dies down until the effect of the primary becomes the stronger, when the relay breaks its back contact and closes its front contact. Then the cycle repeats.

In sending out PCI pulses after the trunk assignment key has been depressed and relay (TG2) has released, relay (PG) pulses as just described with relay (PG1) operating every time relay (PG) closes its back contact. The pulsing must start with the timing condenser discharged and the (PG) relays in a definite condition, with relay (PG) closing its back contact, relays (PG1) and (PG2) operated and relay (PG3) normal. The condenser is discharged and relay (PG) set on its back contact when relay (CI2) operating with relay (SP) normal, grounds out the 300 ohm resistance. When trunk test is made, relay (CI1) operates, which operates relay (PG1), which in turn operates relay (PG2), but relay (PG3) cannot operate because its winding is shunted.

With relay (TG2) normal after relays (PG2) and (CI2) have operated, relay (SP) operates and then relays (PG) and (PG1) start continuous pulsing. Relay (PG2) being operated and locked and relay (PG3) normal before the pulsing begins, the first release of relay (PG1) removes the shunt from relay (PG3) allowing it to operate. The next operation of relay (PG1) shunts relay (PG2) causing it to release, leaving relay (PG3) operated. The next release of relay (PG1) releases relay (PG3). The next operation of relay (PG1) operates relay (PG2) and so the cycle repeats. Each complete cycle, which generates four pulses to transmit one digit, proceeds as follows:

Pulse	PG1	PG2	PG3
1	Up	Up	Down
2	Down	Up	Up
3	Up	Down	Up
4	Down	Down	Down

When operated, relay (PG1) grounds the "FR" lead for a position or blank odd pulse; when normal it grounds the "FT" lead (the 6500 ohm battery is already connected to the "FR" lead) for a light negative even pulse. Relay (GR) operates with relay (PG1) but slightly delayed in order to discharge the trunk capacity.

The winding of relay (PT) is connected to lead "1" of the dial register when relay (PG3) is normal and to lead "3" of the dial register when relay (PG3) is operated. When relay (PT) operates, it connects 6500 ohms battery to the "FT" lead giving the light positive pulse. When relay (PT) is normal it connects ground through back contact of relay (GR) to the "FT" lead, so that both sides of the trunk are grounded momentarily to discharge the trunk capacity. Relay (GR) operates immediately after (PG1), after which the "FT" lead is open to give the blank pulse. For the first pulse relay (PG1) is operated in advance, but relay (GR) does not operate until relay (SP) operates to start the pulsing.

The winding of relay (PR) is connected to lead "2" of the dial register when relay (PG2) is operated and to lead "4" of the dial register when relay (PG2) is normal. Relay (PR) operates when a heavy negative even pulse is required and is normal when a light negative even pulse is required. Operated it connects 115 ohm battery to the "FR" lead, giving the heavy negative pulse. Normal it leaves 6500 ohm battery connected to the "FR" lead, giving the light negative pulse.

The pulses are transmitted in a continuous stream, four pulses to each digit. The first and third pulses of each digit are either blank or light positive, the second and fourth either light or heavy negative. The different combinations of four pulses determines the numeral transmitted for each digit. In addition each negative pulse, whether light or heavy, serves to advance the distant control circuit which receives the pulses and registers the numbers transmitted.

Three different codes of pulse combinations are used: The regular one for the office code and all numerals, except thousands, the thousands code; and the station code. These codes are given in the following table where "n" represents a light negative pulse, "N" heavy negative, "p" light positive and "-" a blank pulse. For a negative pulse battery is connected to the ring lead in the sender. The four letters "J", "M", "R", and "W" corresponding to numerals "5", "6", "7", and "9" are the only station designations provided for. If no station designation is dialed or if any other numeral is dialed in error, a zero will be transmitted.

Regular	Thousands	Stations
0 - n - n	0 - n - n	0 - n - n
1 p n - n	1 - n - N	1 p n - n
2 - N - n	2 p n - n	
3 p N - n	3 p n - N	
4 - n p n	4 - N - n	
5 - n - N	5 - N - N	5 (J) - n p n
6 p n - N	6 p N - n	6 (M) - n - N
7 - N - N	7 p N - N	7 (R) p N - n
8 p N - N	8 - n p n	
9 - n p N	9 - n p N	9 (W) - N - n

After the entire number has been transmitted, relay (FP) is operated. A blank pulse is sent after the fourth pulse of the unit digit with relay (PG) on its back contact, relay (PG1), (PG2), and (FP) operated and relay (PG3) normal. Then relay (PG) breaks its back contact, releasing relay (PG1) which lets relay (PG3) operate. Relay (FP) in operating reverses the connections between the "FT" and "FR" leads and also connects the 115 ohm resistance battery to the "FT" lead, so the release of relay (PG1) starts a heavy positive pulse. After the heavy positive pulse has lasted for the usual time of the pulse, relay (PG) closes its back contact. Usually that would operate relay (PG1), terminating the pulse and releasing relay (PG2); but this time, since relays (FP) and (PG3) are both operated, the back contact of relay (PG) is cut off from relay (PG1) and connected instead to release relay (PG2) directly. Relay (AV1) operates upon the release of relay (PG2) through a front contact of each of the (PCI) progress relays (not shown). The heavy positive pulse continues until the fundamental is broken by the operation of relay (AV2). The operation of relay (AV1) marks the completion of the sender's functions on the call.

More details of the PCI portion of the sender are shown on Fig. 3.

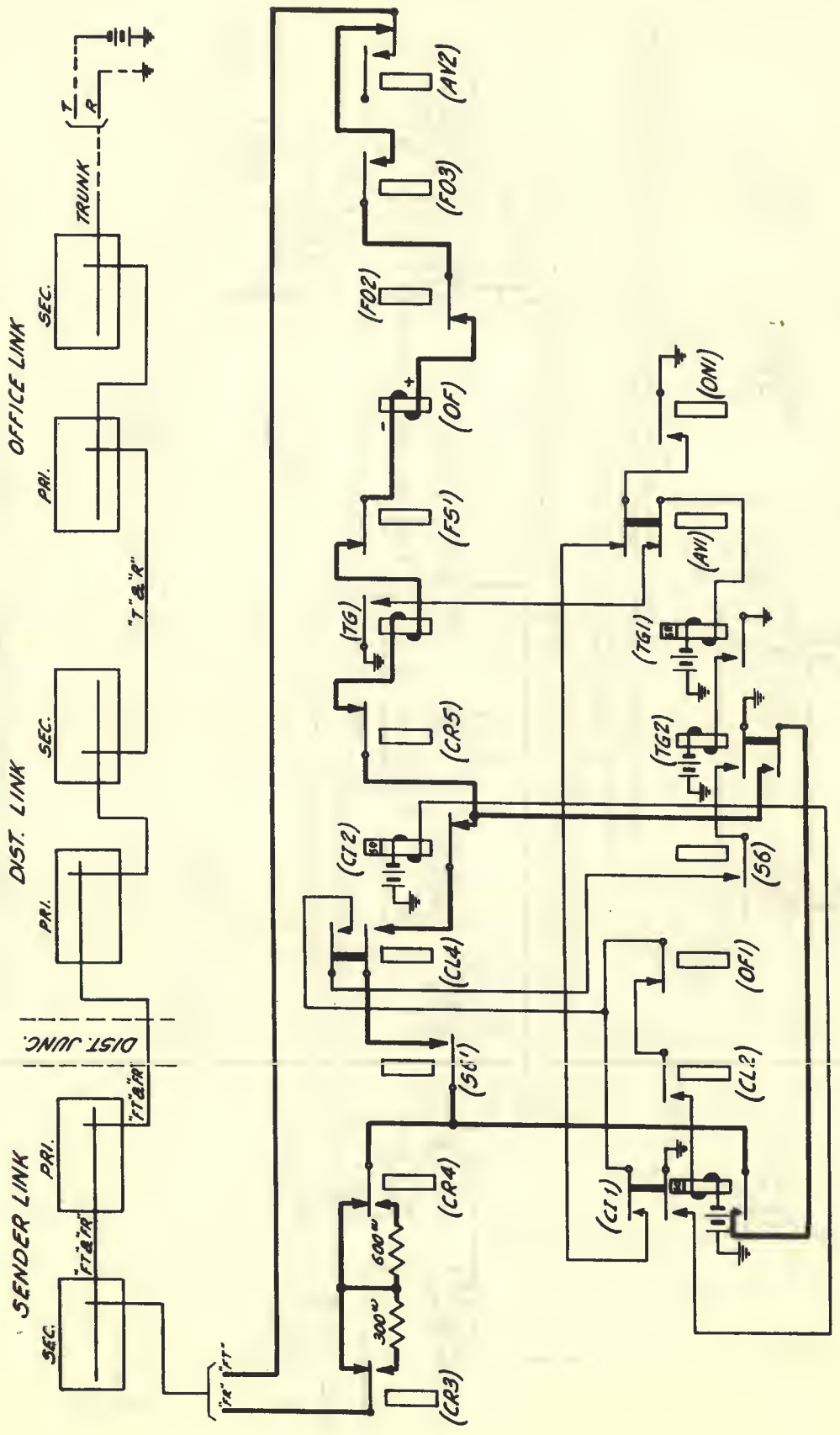


Fig. 1 - Subscriber Sender - PCI Trunk Test

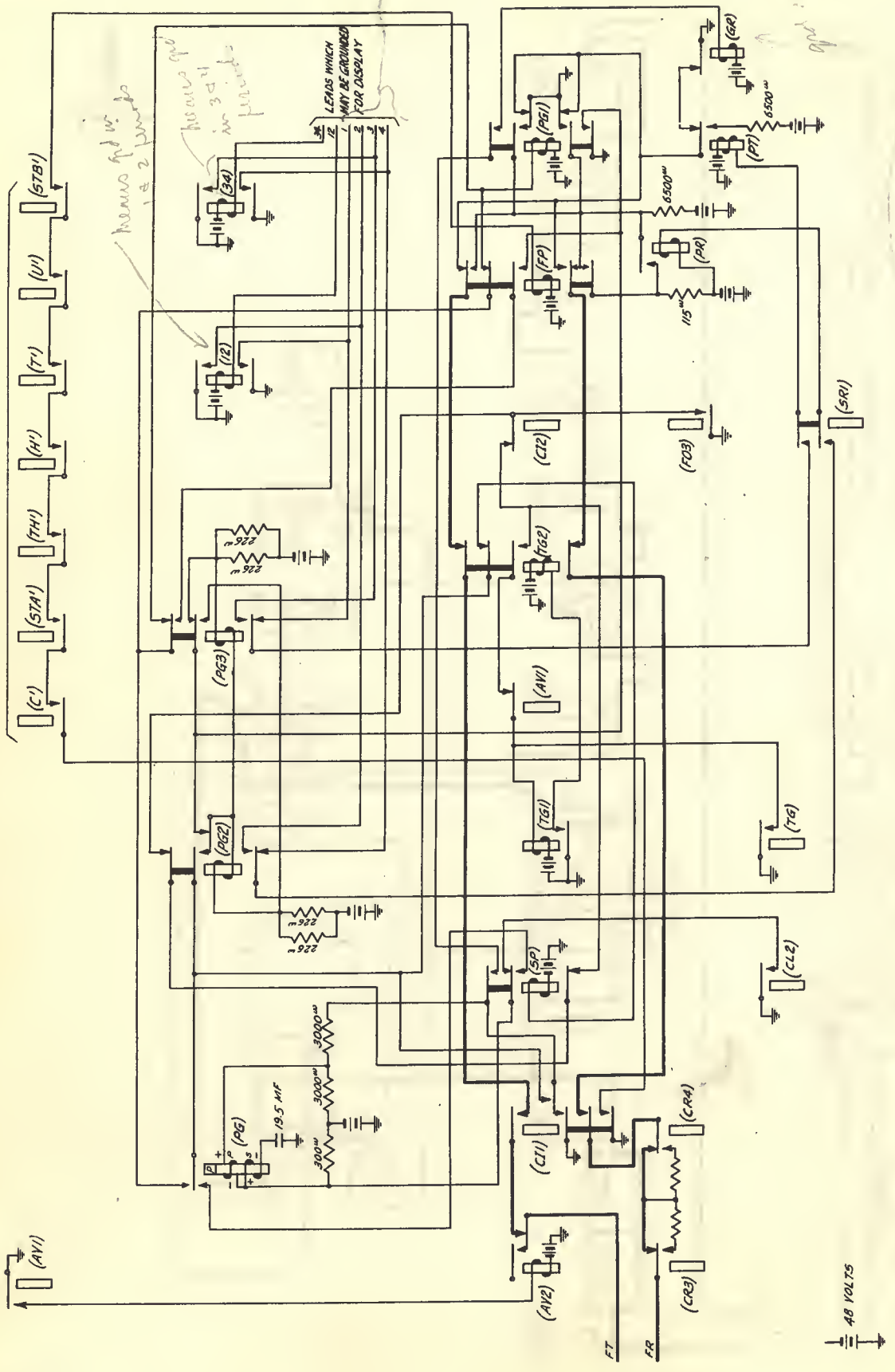
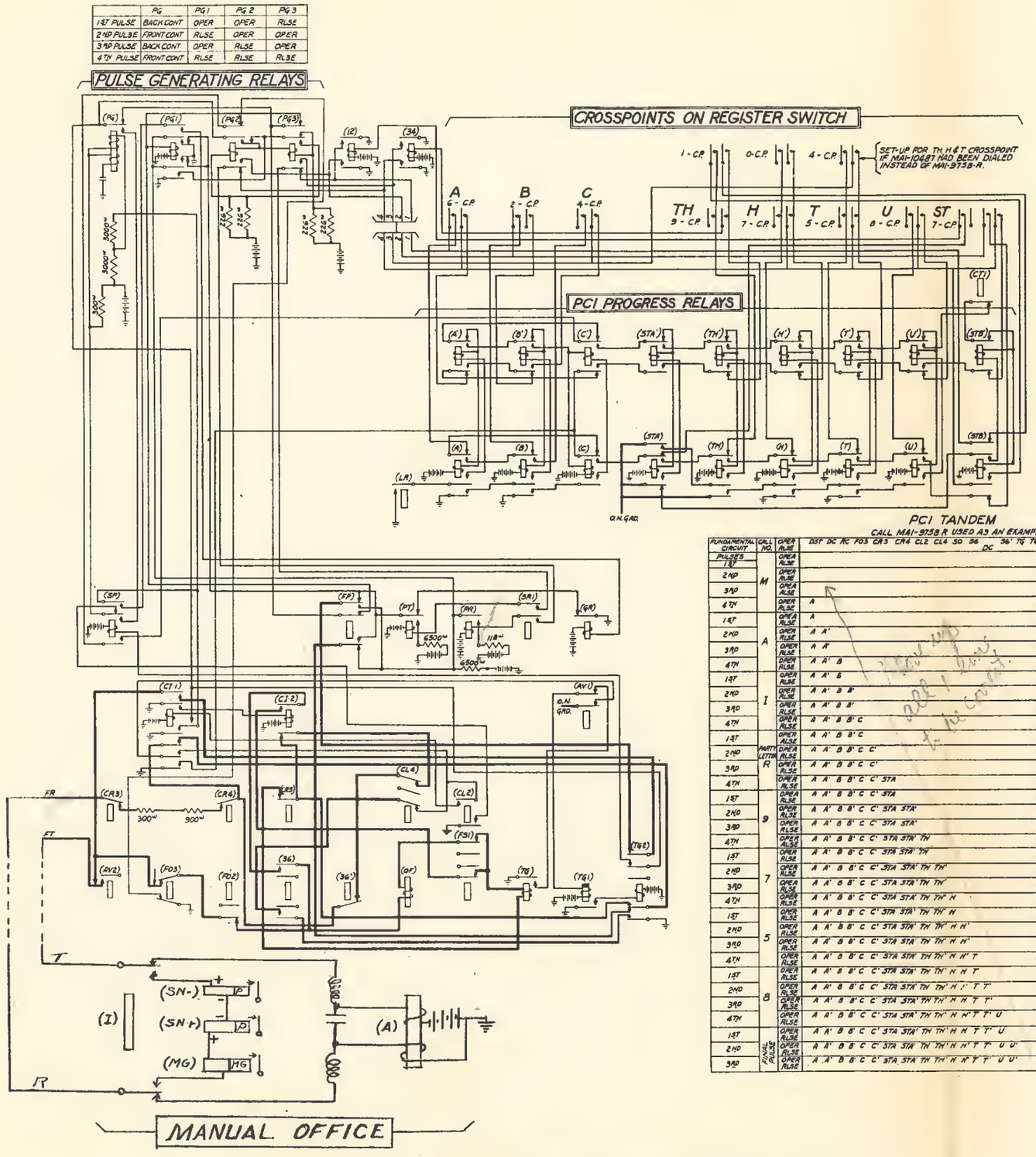


Fig. 2 - Subscriber Sender - Generation of PCI Pulses



	PG	PG1	PG2	PG3
1ST PULSE	BACK CONT	OPER	OPER	RLSE
2ND PULSE	FRONT CONT	RLSE	OPER	OPER
3RD PULSE	BACK CONT	OPER	RLSE	OPER
4TH PULSE	FRONT CONT	RLSE	RLSE	RLSE

FUNDAMENTAL CIRCUIT PULSES	CALL NO.	OPER RLSE	DST DC RC FO3 CR3 CR4 CL2 CL4 SO 36 36' TG TG1 PG2 CI1 CI2 TRUNK ASSIGNED DC TG
1ST		OPER RLSE	PG Δ PG1 PG2 GR +8 PT (N) PULSE TG1 TG2 SP
2ND	M	OPER RLSE	PG % PG1 PG2 PG3 GR +6 PT (N) PULSE
3RD		OPER RLSE	PG Δ PG1 PG2 PG3 GR A +6 PR (-) PULSE
4TH		OPER RLSE	A PG % PG1 PG2 PG3 GR +6 PR (N) PULSE
1ST		OPER RLSE	A PG Δ PG1 PG2 A' GR +2 PR (-) PULSE
2ND	A	OPER RLSE	A A' PG % PG1 PG2 PG3 GR +2 PR (N) PULSE
3RD		OPER RLSE	A A' PG Δ PG1 PG2 PG3 GR B +2 PR (-) PULSE
4TH		OPER RLSE	A A' B PG % PG1 PG2 PG3 GR +2 PT (N) PULSE
1ST		OPER RLSE	A A' B PG Δ PG1 PG2 B' GR +4 PT (-) PULSE
2ND	I	OPER RLSE	A A' B B' PG % PG1 PG2 PG3 GR +4 PT (N) PULSE
3RD		OPER RLSE	A A' B B' PG Δ PG1 PG2 PG3 GR C +4 PT 12 (N) PULSE
4TH		OPER RLSE	A A' B B' C PG % PG1 PG2 PG3 GR +4 PT 12 (N) PULSE
1ST		OPER RLSE	A A' B B' C PG Δ PG1 PG2 C' GR +7 12 PR PT (P) PULSE
2ND	PARITY LETTER R	OPER RLSE	A A' B B' C C' PG % PG1 PG2 PG3 GR +7 12 PR PT (N) PULSE
3RD		OPER RLSE	A A' B B' C C' PG Δ PG1 PG2 PG3 GR STA +7 (-) PULSE
4TH		OPER RLSE	A A' B B' C C' STA PG % PG1 PG2 PG3 GR +7 (N) PULSE
1ST		OPER RLSE	A A' B B' C C' STA PG Δ PG1 PG2 STA' GR +9 34 (-) PULSE
2ND	9	OPER RLSE	A A' B B' C C' STA STA' PG % PG1 PG2 PG3 GR +9 34 PT (N) PULSE
3RD		OPER RLSE	A A' B B' C C' STA STA' PG Δ PG1 PG2 PG3 GR TH +9 34 PR PT (N) PULSE
4TH		OPER RLSE	A A' B B' C C' STA STA' TH PG % PG1 PG2 PG3 GR +9 34 PR (N) PULSE
1ST		OPER RLSE	A A' B B' C C' STA STA' TH PG Δ PG1 PG2 TH' GR +7 PR (-) PULSE
2ND	7	OPER RLSE	A A' B B' C C' STA STA' TH TH' PG % PG1 PG2 PG3 GR +7 PR (N) PULSE
3RD		OPER RLSE	A A' B B' C C' STA STA' TH TH' PG Δ PG1 PG2 PG3 GR H +7 PR (-) PULSE
4TH		OPER RLSE	A A' B B' C C' STA STA' TH TH' H PG % PG1 PG2 PG3 GR +7 PR (N) PULSE
1ST		OPER RLSE	A A' B B' C C' STA STA' TH TH' H PG Δ PG1 PG2 H' GR +5 (-) PULSE
2ND	5	OPER RLSE	A A' B B' C C' STA STA' TH TH' H H' PG % PG1 PG2 PG3 GR +5 (N) PULSE
3RD		OPER RLSE	A A' B B' C C' STA STA' TH TH' H H' PG Δ PG1 PG2 PG3 GR T +5 12 PR (-) PULSE
4TH		OPER RLSE	A A' B B' C C' STA STA' TH TH' H H' T PG Δ PG1 PG2 PG3 GR +5 12 PR (N) PULSE
1ST		OPER RLSE	A A' B B' C C' STA STA' TH TH' H H' T PG Δ PG1 PG2 T' GR +10 12 PR PT (P) PULSE
2ND		OPER RLSE	A A' B B' C C' STA STA' TH TH' H H' T T' PG % PG1 PG2 PG3 GR +8 12 PR (N) PULSE
3RD	8	OPER RLSE	A A' B B' C C' STA STA' TH TH' H H' T T' PG Δ PG1 PG2 PG3 GR U +8 PR (-) PULSE
4TH		OPER RLSE	A A' B B' C C' STA STA' TH TH' H H' T T' U PG % PG1 PG2 PG3 GR +8 PR (N) PULSE
1ST		OPER RLSE	A A' B B' C C' STA STA' TH TH' H H' T T' U PG Δ PG1 PG2 GR U' FP (-) PULSE
2ND	FINAL PULSE	OPER RLSE	A A' B B' C C' STA STA' TH TH' H H' T T' U U' PG % PG1 PG2 PG3 GR FP (P) PULSE
3RD		OPER RLSE	A A' B B' C C' STA STA' TH TH' H H' T T' U U' PG Δ PG1 PG2 PG3 GR FP (N) PULSE AY CI1 CI2 FUNDAMENTAL OPEN

Fig. 3 - Subscriber Sender - Set-up for PCI Calls

CHAPTER 27 - SPECIAL CALLS

There are four types of special calls which may be set up by the marker, namely,

(a) Number checking calls

(b) No test calls, including calls from a verification operator at the DSA switchboard or from the test desk

(c) No hunt calls from the outgoing trunk test frame for routine tests of subscriber lines or from the message register rack for use in connection with message register tests

(d) Calls from the test desk which are neither no test nor no hunt.

When a special call is to be established, the marker connector involved selects one of the two terminating markers arranged to handle this traffic and operates the special (SPL) relay of the marker seized. This relay prepares operating circuits for relays operated later to indicate which type of special call is to be set up. The (NC1) relay operates for number checking calls, the (NT) relay for no test calls from the DSA switchboard or from the test desk, the (NH) relay operates for no hunt calls from the outgoing trunk test frame or line message register rack and the (NT1) relay operates for calls from the test desk which are neither no test nor no hunt. The operation of the (SPL) relay also opens the circuit for operating one of the (LO-19) relays, thus blocking the marker until the (NC1), (NT), (NH), or (NT1) relay has operated. The number group start lead is under control of relay (LKO) which in turn is under control of relay (SPL) in the same marker and relay (LKO) in the mate number checking marker. This is in effect a lockout circuit, whose start lead is under control of relay (SPL) which permits only one special call at a time to be made in an office. This prevents interference between number checking and no test calls and interference between two number checking calls which might be caused by having two markers testing on the same sleeve at one time.

NUMBER CHECKING CALLS

Number checking calls may originate either at the DSA switchboard or at a toll switchboard. "A" switchboard number checking calls are handled as illustrated on Fig. 1 by special number checking trunks from the "A" switchboard which are connected through a number checking link to number checking senders in which the number to be checked is set up from the operator's keyset. For toll number checking calls, incoming trunks are provided as indicated on Fig. 2 which may be seized by the toll operator. The number to be checked is passed by the toll operator over this trunk to the "B" operator in the crossbar office. This number is then set up in a "B" sender and is transmitted to the marker in the usual way.

Registration in the marker, translation and seizure of a number group connector frame and of the incoming link and connector proceed as for a regular call up to the point at which the line busy test is made. This busy test is cancelled. Although the (S) relays may operate from ground on a busy terminal sleeve, the (S) relays are made ineffective in returning a busy signal because the ground which the (TLT) relay ordinarily closes is opened in this case at a break contact of the (SPL) relay. When the incoming frame is seized, the (NC1) relay in the terminating marker operates from a ground supplied by the incoming trunk circuit through the incoming connector as shown on Fig. 3. The operation of relay (NC1) causes the operation of relays (NC2-5), (NC6-9) and when the (TBK) relay is operated a circuit through the (NC1) relay also operates relays (NC10-13).

This same circuit also continues after the (NC10-13) relays are operated and causes the operation of relay (NC14). When the (NC2-5) relays have operated, the circuits to the (S) relays are opened and the sleeve leads are directed to the number checking circuit. At the time the (NC14) relay operated, the (NCT) relay starts to release. The (NCT) relay had previously been operated by ground supplied when the (SPL) relay operated. The (NCT) relay is a slow release relay to introduce a time element allowed for the return of a number checking signal. The operation of the (NC1) relay also opens the circuits to the ringing and tone control relays.

When the (NC14) relay has operated, a circuit is closed from the 130 cycle generator through the (NCC) relay normal, (NC14) relay operated, (UT) relay normal or operated, (NC6-9) relays operated through the resistance and condenser and (NC10-13) relays operated, (NC2-5) relays operated to the "NS" leads. This 135 cycle path will be closed to the sleeve of the called line and if the called line is one of a terminal hunting group the (HT) relays corresponding to the first and intermediate lines will have operated in the usual manner. The operation of the (HT) relays will extend the 135 cycle path through the contacts of the operated (HT) relays to each of the lines of the terminal hunting group in the same twenty block. If the group being number checked is one of several groups which it is desired to number check in one operation, the (XG) relay, not shown, in the number group connector circuit facilitates this by means of converting last lines into intermediate lines so that for number checking purposes the marker converts the several groups into one group. These groups must be consecutively located in the number group connector but may be on more than one twenty block relay.

The 135 cycle current is applied to the sleeve circuit. If the sleeve is connected to an "A" operator trunk, the 135 cycle current will be extended through the cord circuit and condenser in the cord circuit and will return to the marker over the operated talking key in the number checking position circuit, the number checking link, the number checking incoming trunk over lead check tone local "CTL" terminating in the (NC) relay of the marker which will respond to the 135 cycle current and cause the operation of relay (NCA).

If the sleeve is connected to a trunk to the toll board, the 135 cycle current may cause the operation of a responding relay in the sleeve signal repeating circuit associated with the toll trunks which in turn will send a direct ground signal into the marker over lead "CTP" and cause the operation of relay (TOK). If the sleeve signal repeating circuits are not equipped with a relay which responds to 135 cycle current, the 135 cycle path will be continued over lead check tone toll "CTT" and by means of "F" wiring in the marker will cause the operation of relay (NC). Relays (NC) and (NCA) are arranged so that if relay (NCA) operates, it is an indication of satisfactory completion of the number checking circuit. The time element allowed by the (NCA) relay covers the effect of surges which might cause a momentary operation and release of the (NC) relay.

The operation of relay (NC) operates relay (NCA) which in turn operates relay (OK). Relay (NCA) also removes ground from the armature of the (NCT) relay to make it ineffective in causing a failure signal to be transmitted or in causing a test to be made of additional terminal hunting lines as described below. Relay (OK) operates the (RV) and (RC) relays which cause leads "RV" and "RC" to the trunk to be grounded as previously described as an indication of a satisfactory check. The operating circuit of relay (OR) is opened by relays (OK), (RC1), and (RV1) and this slow relay releases allowing enough time during its release to insure the operation of the trunk relays. Relay (OR) operates relay (SRL) in turn operating relays (CON1), (CON2), (GT1), and (GT2), grounding the release lead and releasing the marker.

In case all of the lines of a terminal hunting group are not in the same twenty block and additional lines are located in the next twenty block the (HT19) relay will be operated to indicate this and the 135 cycle current will be carried through the (HT) relays and rectified by varistor (C) to operate relay (NCB). This connects the (PG) relay winding to ground on the back contact of relay (NCA) when relay (NCT) releases. Relay (NCT) operates from ground on relay (SPL) and starts to release when relay (NC14) operates. The release of relay (NCT) operates relay (PG) which causes the next twenty block to be connected to the marker as on a regular call. Relay (NCT) is slow in releasing to allow time for the (NC), (NCA), and (OK) relays to operate if a line in the first twenty block is used for the call being number checked. The action of the marker for the second and succeeding twenty blocks is the same as for the first.

If the number check is unsuccessful the (NCC) relay will operate when the (NCT) relay has released. The operation of the (NCC) relay releases the (NC10-13) relays for the purpose of removing the (NC) condensers from the circuit so that these condensers cannot interfere with the operating circuit for the (L) relay. The (NCC) relay provides a path for maintaining the (NC14) relay operated and when the (NC10-13) relays are released, a circuit is closed which causes the operation of the (NC15-16) relays. With the (NCC) and the (NC15-16) relays operated, a circuit is closed for the operation of the (L) relay corresponding to the individual line called or to the last line of a terminal hunting group. The (NCC) relay transfers from the 135 cycle power supply to ground for operating the (L) relay. When the (NCC) relay operated, the (NCD) relay started to release. The (NCD) relay is slow to release, to cover the operation including the (L) relay and the subsequent result of the (L) relay grounding the "NF" and "NC" leads.

If the (L) relay which is operated corresponds to a line not cross connected for jump hunting, the (LC-) and (CA) or (CB) relays cannot operate because their battery supply is open at the (NC1) relay. The (NCD) relay allows time for the return of a successful number check signal and if the (NCC) relay is still operated when the (NCD) relay releases, a number check failure is indicated and causes the operation of the (NCF) relay. When the (NCF) relay operates, it operates the (RV) relay, to set up a number check failure signal in the incoming. The (RV) relay starts the (OR) relay to release which allows the subsequent operation of the (SRL) relay for starting the marker release signal.

In case there is an additional group of terminal hunting lines in another part of the number group which it is desired to check with the first tested lines, the jump hunting feature of the marker will gain access to them. This is accomplished by the operation of relay (NCC) which operates one of relays (L0) to (L19) as described above. The (L-) relay grounds leads "NF" and "NC" which through jump hunting cross-connections operate a (JF-) and a (JC-) relay and causes the additional group of lines to be connected as on a regular jump hunting call. When the first twenty block is released relays (NC10) to (NC16) and (NCC) release and when the second twenty block relay operates the additional lines are checked in the same manner as the first group.

NO TEST CALLS

No test calls are made when an operator or test board man wishes to connect to a given line over a busy condition. No test calls may originate at DSA switchboard positions handling verification service, as illustrated on Fig. 4 or at test desks as illustrated on Fig. 5. If the line called is idle, the connection to that line will be set up over the regular train. The only difference between this call and a regular call is that terminal hunting is cancelled and because the "RT" and "TT" leads are open at the trunk, tests of the subscriber line and tests for plugged-up condition are omitted. When the marker connector seizes the marker on any special call including no test calls, relay (SPL) operates and closes lead "NT" as shown on Fig. 6. When the no test incoming trunk (F) relay operates, it

operates relay (NT). Relay (NT) holds open the operating paths of relays (HT0-19), thus preventing terminal hunting and making all lines appear as individual lines.

If the line is busy a connection is set up over a no test train to the line link which is connected to the busy line. Registration, translation, and seizure of the number group connector and incoming frames proceed up to the point at which the line busy test is made. This test is delayed by the operation of the (SPL) relay which holds open the (L) relay operating circuit until the (NT1) relay operates and closes the path opened at the (SPL) relay. The (NT) relay operates the (NTH) relay by ground from relay (TE) and also operates the (NT1) relay. The (NT1) relay closes a circuit through the tens and units relay contacts to the armature of the sleeve relay corresponding to the called line. If this relay is normal the call is set up in the regular manner but if the line is busy the sleeve relay will be operated and ground is connected through the front contact of the (S) relay and back contact of the (HT) relay, through the front contact of the (NT) relay and the (NTR) relay to operate relay (NTT) as a signal to employ the no test train. The (NTT) relay operates the (NC2-5) relays and when these relays are operated the armature of the (JB) relay is grounded and if the no test connector is busy the (JB) relay will operate and in turn will operate the (OF) relay, and the overflow signal will be set up.

The (NTT) relay operates the (NC2-5) relays in order to release the (S) relay which had operated on the busy condition. The (S) relay must be released to prepare the circuit for operation of the associated (L) relay. The (L) relay operates to ground closed at the (NT1) relay. The (NTT) relay also closes a circuit from 20-28 volts positive battery to the sleeve lead when the (L) relay operates. The (NTT) relay also operates the (LFA) and (LFB) relays for transferring the line link test leads to the link finder (LF) relays.

There are ten (LF) relays one applied to each of the ten line links having access to the called line. The ten links are tested for the positive battery potential and the (LF) relay, which corresponds to the link which has this potential connected to it over the "NS" lead, will operate. The line link connected to the called line is thus identified by the operation of one of the (LF) relays. The (LF-) relay operates the corresponding (CH-) relay which locks and energizes the select magnet corresponding to the desired line link, and releases relay (TE). The release of relay (TE) releases relay (NTH) which connects ground to the "NT" lead to energize the hold magnet of the no test connector and then energize the hold magnet of the line link no test vertical and thus establish the connection between the no test incoming trunk and the line link which is connected to the called line. The (NTH) relay is slow in releasing to allow time for the select magnet to energize. With the (NTH) relay released, the (NTR) relay releases, grounding the "RL" lead to cause the sender to release the marker in the regular manner. The (NTR) relay is slow in releasing to permit the hold magnets to energize, close the crosspoints and operate the holding relay of the incoming trunk.

In some cases none of the (LF-) relays will operate. This may be due to a trouble ground on the sleeve, or due to a make busy ground applied to the sleeves by means of a key in some special line circuits, or due to the fact that the connection which is holding the called line busy is established manually through the DSA switchboard instead of through the switches. In this last case the special line circuit will connect a make busy ground to the sleeve by means of a relay contact.

In case none of the (LF) relays operate, the (NTB) relay operates from a contact of the (TKT) relay while the (TE) relay is still operated and causes the release of the (NCT) relay, the (NCT) relay having been operated early. The (NCT) relay is slow release and if the (TE) relay is still operated when the (NCT) relay is released, the (BB) relay is operated which returns a line busy signal to the incoming trunk circuit, excepting that when the called manual line is arranged for tip party ringing the signal is changed to the overflow signal.

NO HUNT CALLS

No hunt calls may originate at the outgoing trunk test frame for routine tests of subscriber lines or at the line message register rack in connection with message register tests. They are the same as regular calls except that terminal hunting is cancelled and line tests and plug-up tests are omitted, because the "RT" and "TT" leads are open. Relay (SPL) operates from the marker connector and permits relay (NH) to operate from the incoming trunk over the "NH" lead. The (NH) relay holds open the operating circuit for relays (LE1) and (LE2) the latter in turn holding open the operating paths for relays (HT0) to (HT19), thus preventing terminal hunting.

TEST DESK CALLS WHICH ARE NEITHER NO TEST NOR NO HUNT

Calls originating at the test desk over trunks which are neither no test nor no hunt, select a special marker in the usual way and operate relay (SPL). Relay (NT1) operates over lead "NN" after the incoming is seized. The call proceeds as a regular call except that tests of subscriber line and tests for the plugging-up condition are omitted because the "RT" and "TT" leads are open at the trunk and the continuity test is passed by due to the fact that a make contact of relay (SPL) makes the "TLH" contact ineffective.

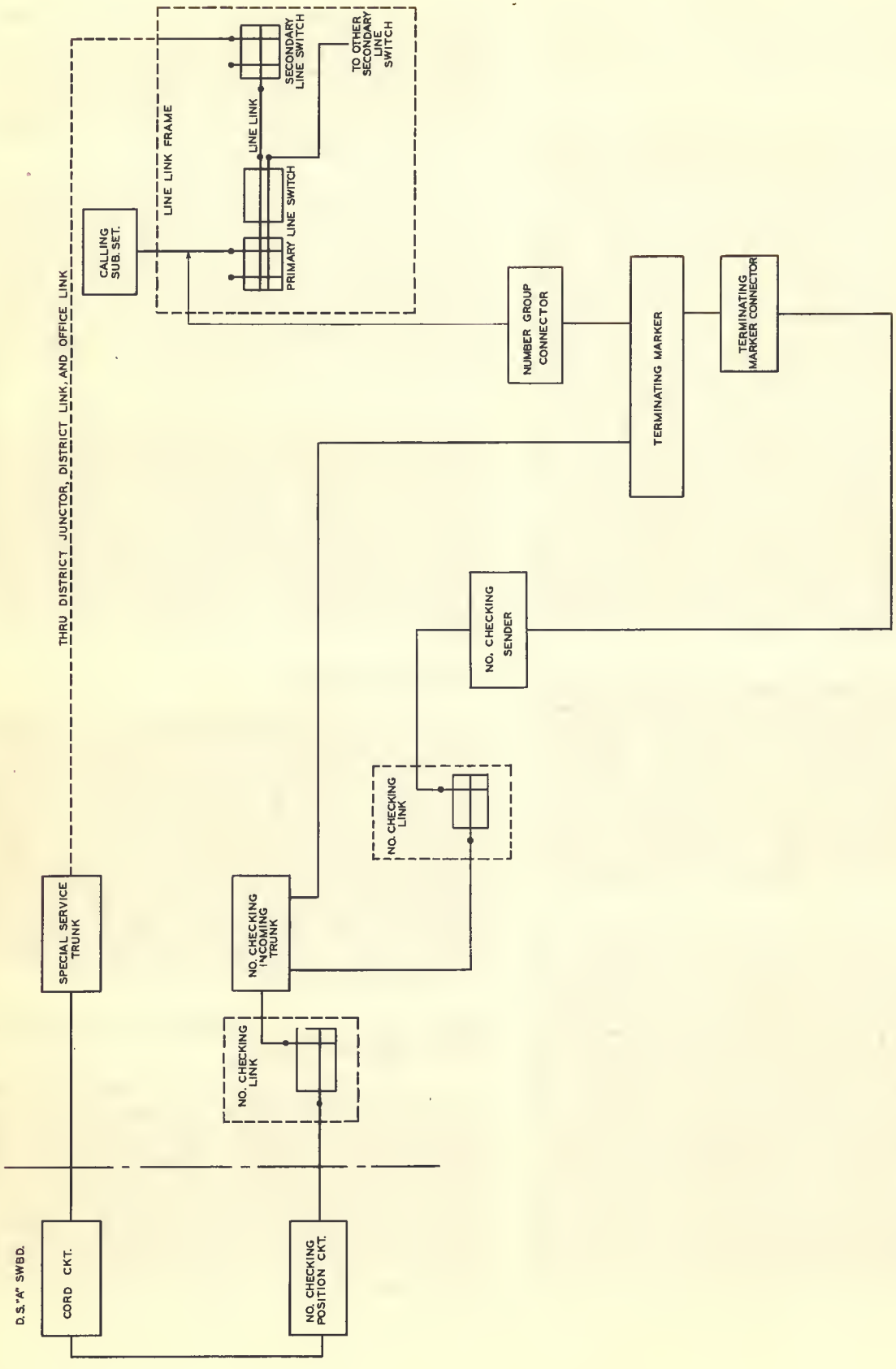


Fig. 1 - Schematic of Trunking for Number Checking Calls from "A" Switchboard

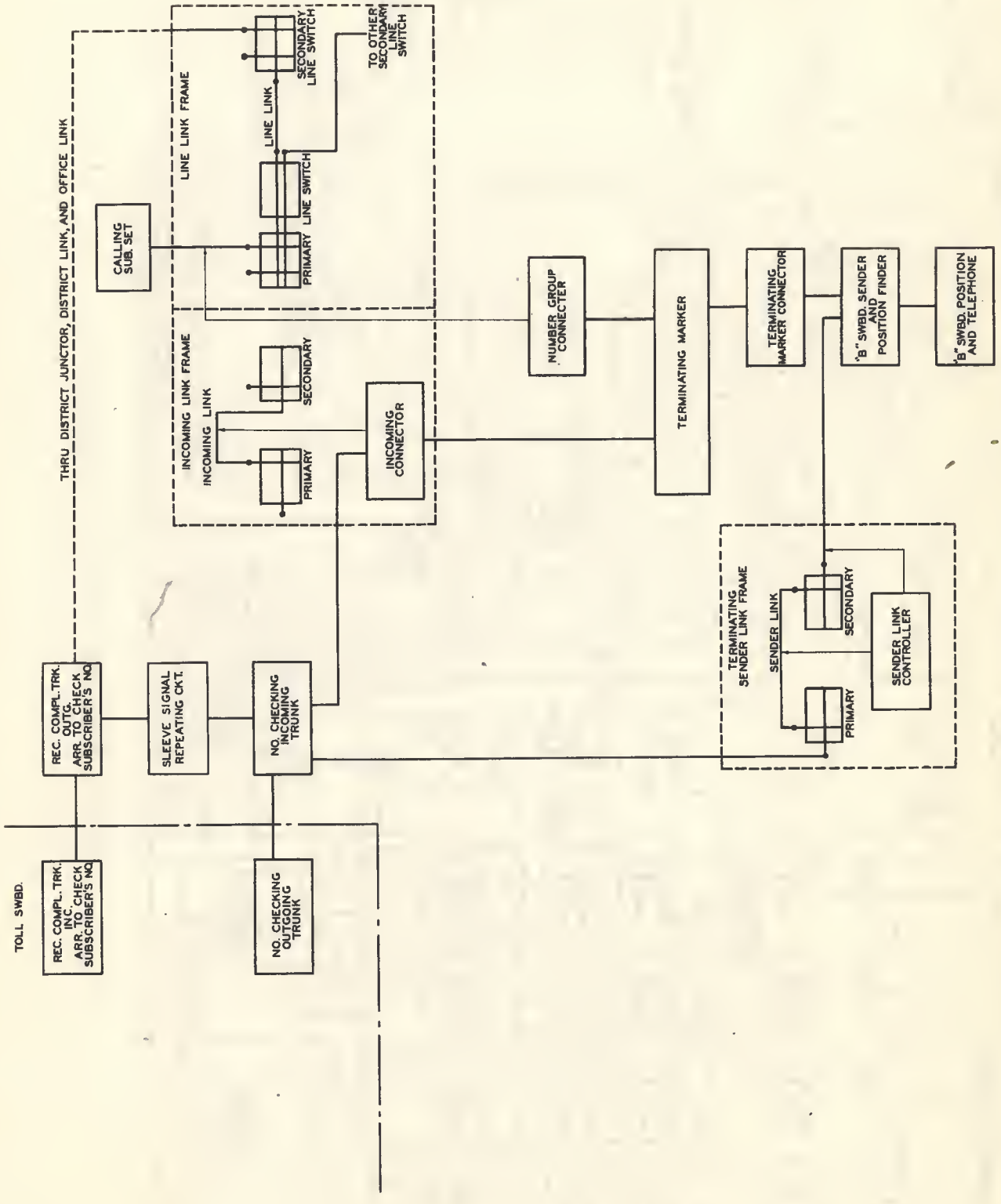


Fig. 2 - Schematic of Trunking for Number Checking Calls from Toll Switchboard

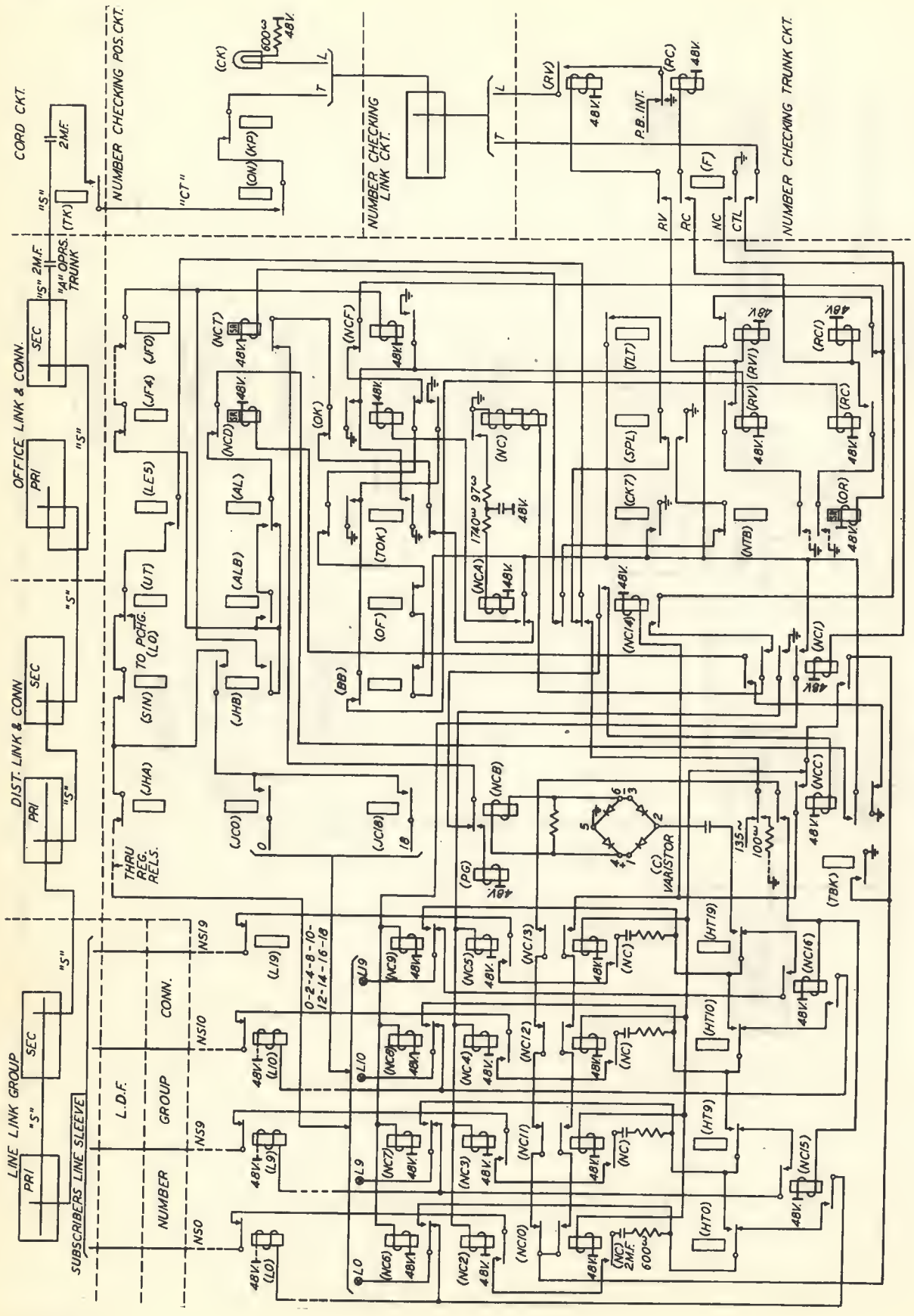


Fig. 3 - Terminating Marker Number Checking Call

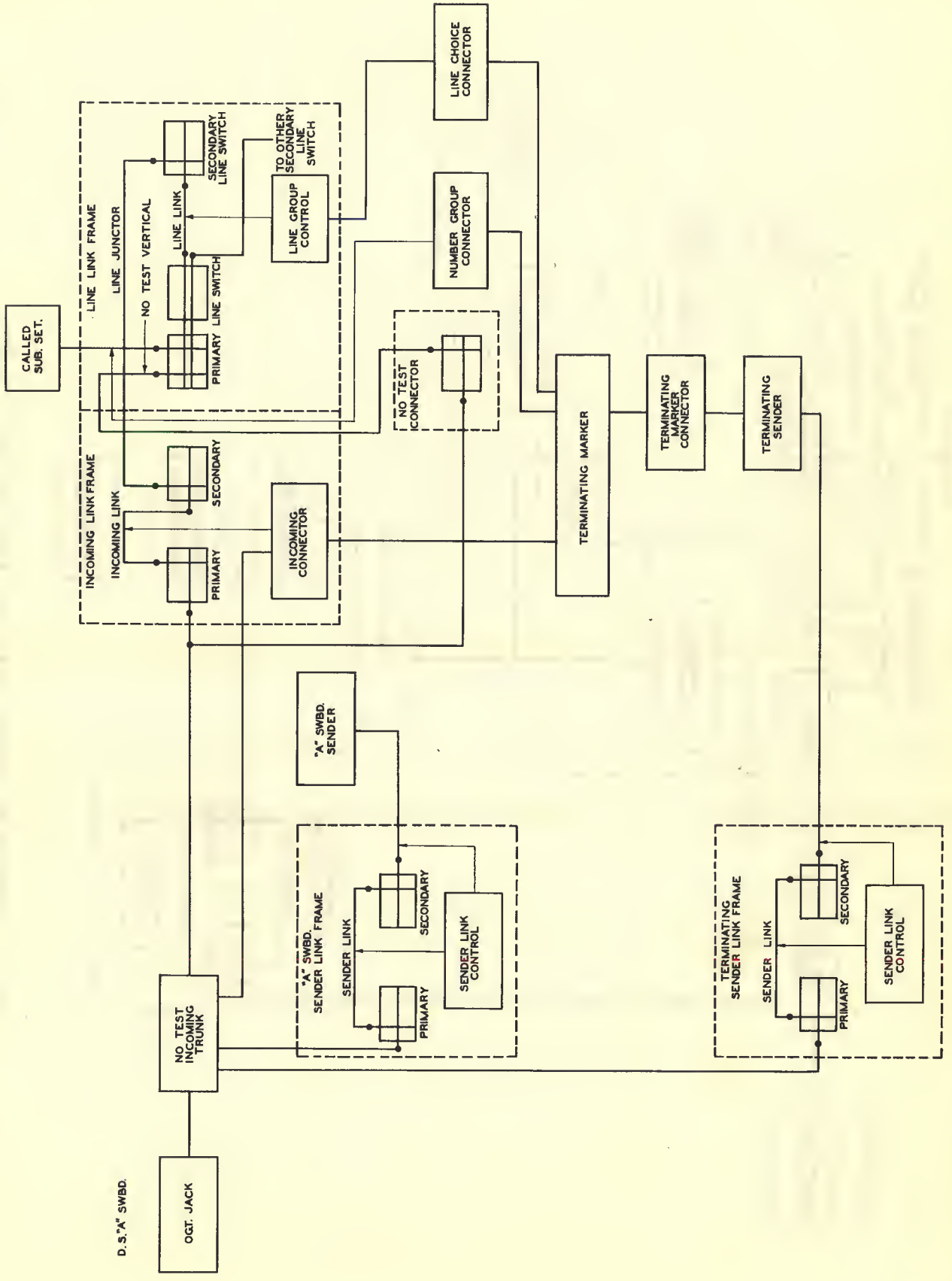


Fig. 4 - Schematic of Trunking for No Test Calls from "A" Switchboard

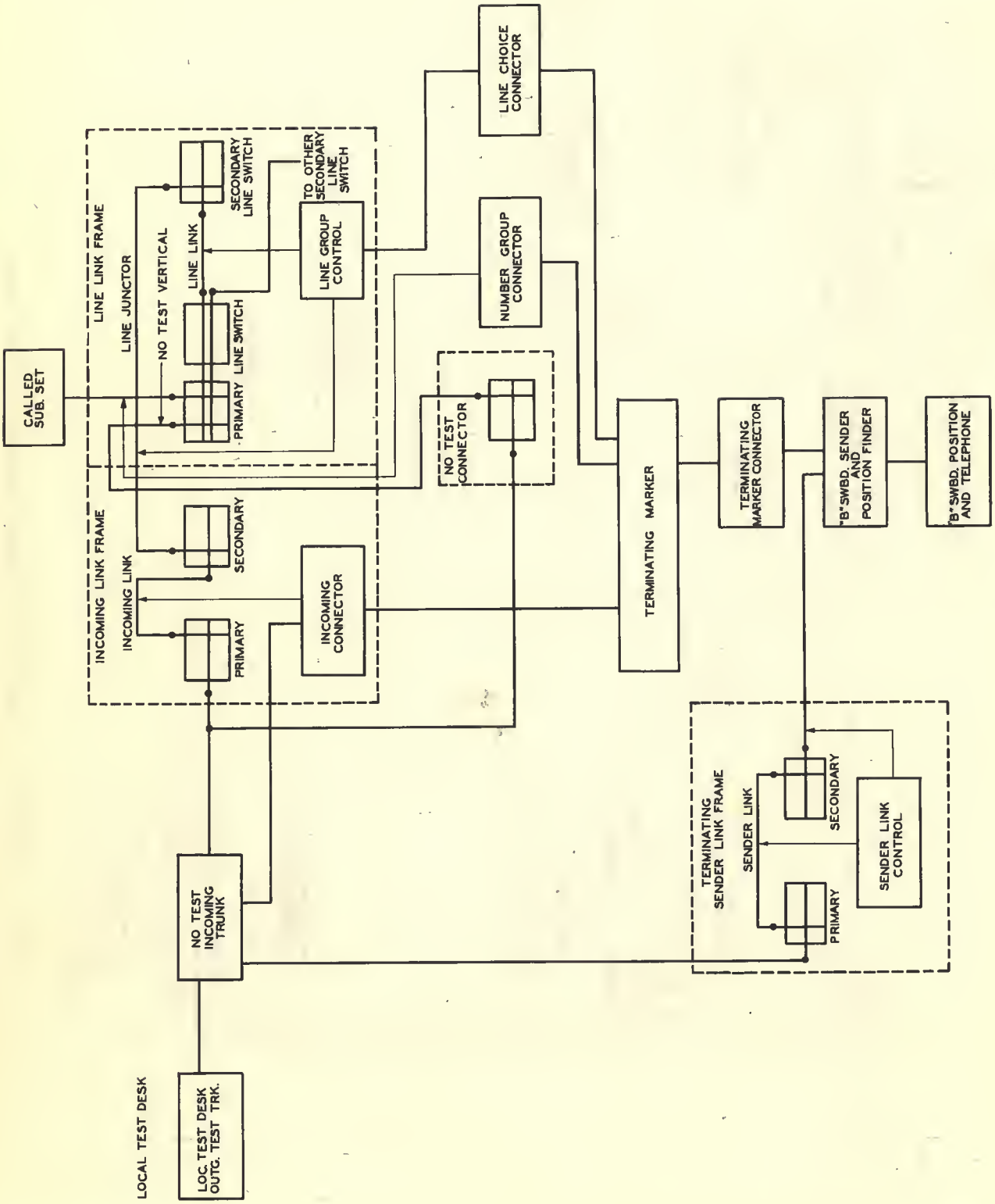


Fig. 5 - Schematic of Trunking for No Test Calls from Local Test Desk

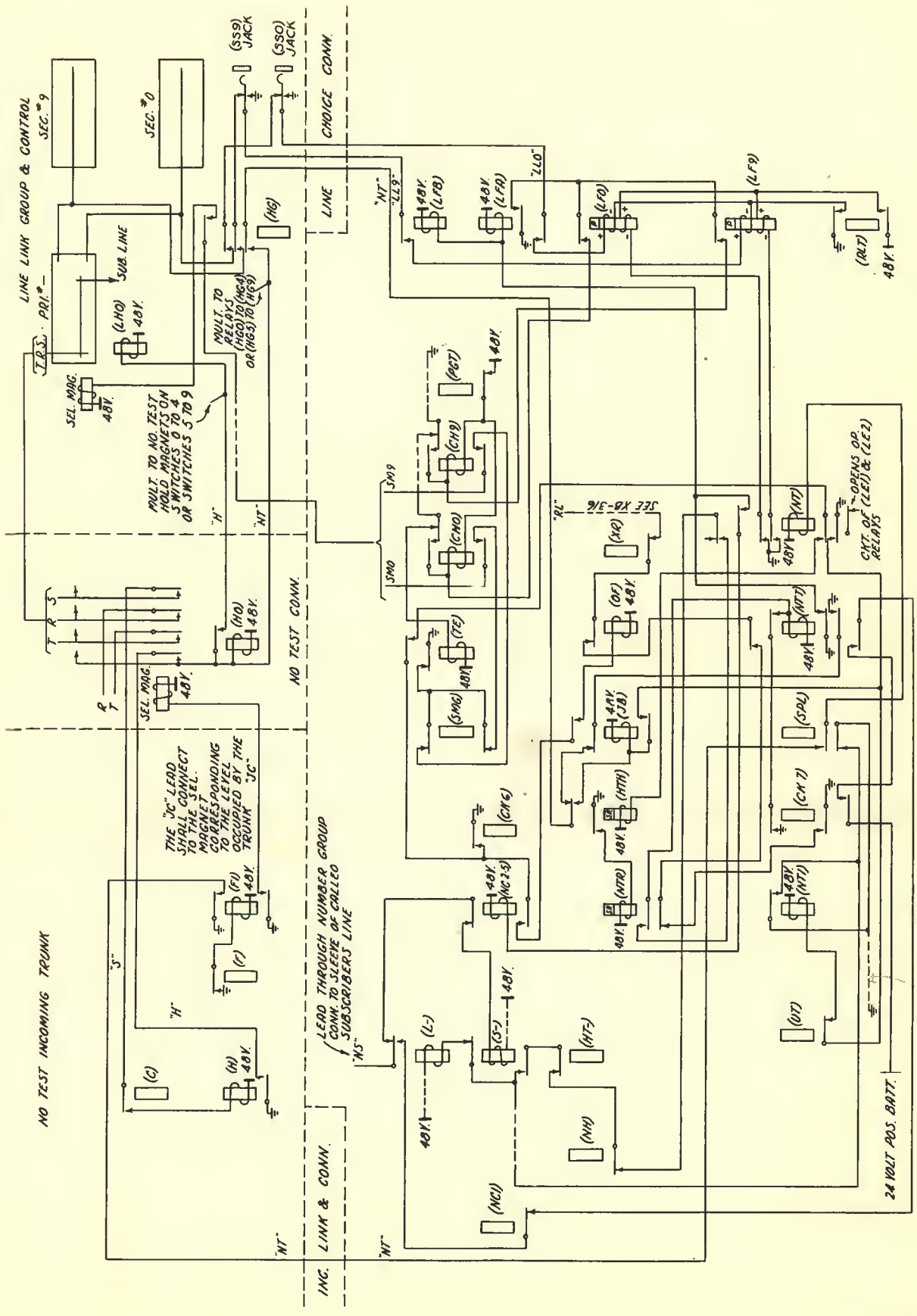


Fig. 6 - Terminating Marker No Test Call

CHAPTER 28 - OPERATION OF COIN CIRCUITS

A subscriber using a coin telephone originates a call in the same manner as when using a non-coin telephone except that it is necessary to deposit a coin in the subset. There are two kinds of coin service. "Coin first" which is used extensively and "dial tone first" which is used only in a few areas.

DIAL TONE FIRST OPERATION

When dial tone first service is provided, the subscriber may start any call and complete all free calls without depositing a coin. The subscriber senders must be provided with a coin feature for testing for the presence of a coin before the call is completed on full selector and PCI type calls. Coin test is cancelled on zero operator and permanent signal calls.

COIN TEST CANCELLED

If a non-coin line is calling, or if the first digit is zero or is not registered at all, relay (CTR) in the subscriber sender will not operate to prepare for the coin test, and relay (CCT) will operate through a back contact of (CTR) as soon as (DRL) operates on receipt of a release signal from the marker (see Fig. 1). The operation of (CCT) relay prevents the other coin test relays from being brought into action. Thus the coin test is not made and no sender functions are delayed to await it.

COIN TEST STARTED

Relay (CTR) operates if a class of service relay has operated which indicates a coin class, when any first digit except zero is registered. Relays (CT) (not shown) and (CT1) operate when (STL) operates to show that dialing is complete and therefore that the line is available for coin test.

GROUND TEST

(CT) and (CT1) relays together disconnect the "T" and "R" leads from the dialing circuit and connect them through windings of (CLR), back contacts of (GTT), windings of (GT), and resistances, the "T" lead to ground and the "R" lead to negative 110 volt coin battery. The operating winding of the (L) relay is grounded through a resistance to hold the relay operated while it is cut off from the line, and (CLR) serves to maintain switchhook control as will be described later.

If there is no coin in the box or other ground on the line except the allowable 10,000 ohms leak, relay (GT) will not obtain enough current to operate and the test will not progress. If there is a coin in the box or any ground having the approximate resistance or less of the coin magnet, (GT) will operate and lock up, thus signifying the satisfaction of the ground test.

SOLID GROUND TEST

When relay (GT) operates it is followed by (GTT), which disconnects the line from the windings of (GT) and connects it instead through windings of (SGT) to ground and to negative 110 volt battery without the interposition of the resistances.

If the only ground on the line is the high resistance ground due to a coin in the box, (SGT) relay will not get enough current to operate, but if there is a solid ground on the line it will operate and will be followed by (SGA) which locks up.

The operation of (GTT) breaks the operating circuit of (CTR) but if (SGA) operates, it locks (CTR) before it has had time to release, so (CTR) remains locked up and the test will not progress.

If there is no solid ground on the line so that (SGA) relay does not operate, (CTR) will release. This operates (CCT) relay, which releases all the coin test relays still operated. The coin test is now fully satisfied and any sender function which awaited it may proceed.

A momentary surge due to line capacity may operate the (SGT) relay falsely, but the (SGA) relay is slow operate and will not respond to a momentary operation of the (SGT) relay.

SWITCHHOOK CONTROL

While the line is connected to the coin test relays instead of to the (L) relay, the latter being held operated by a by-pass, switchhook control is maintained by (CLR) relay. This is a polarized relay biased by its tertiary winding, and it remains operated as long as the receiver is off the hook, regardless of any ground condition on the line.

If the subscriber hangs up, the (CLR) relay releases and shunts the (L) relay (not shown) by a 52-1/2 ohm resistance battery. The (L) relay thereupon releases and the further action of the sender is the same as if the coin test had not been in progress when the call was abandoned.

FAILURE OF COIN TEST

When (CT1) relay operates at the start of the coin test, it grounds interrupter (SD) and connects a locking ground to relay (H). The interrupter cycles are counted on relays (H), (H'), (T), (T'), (U), and (U'), each cycle causing one pair of relays to operate and lock.

If the coin test fails, then after the timing has continued from two to three seconds, and the above pairs of relays are all operated, the next closure of the interrupter operates the (CNL) relay which locks, lights the coin lamp, and grounds the auxiliary signal circuit.

MONITORING

Upon observing the lamp signal the operator will plug into the talking jack with a talking cord. This operates relay (MS), which extinguishes the lamp and cuts off the auxiliary signal for as long as the plug is in the jack. (MS) operates (MS1), and the two relays together close the "T" and "R" leads to the talking jack and by pass the circuit through the primary and secondary windings of (CLR) relay so as to hold that operated.

The transfer of the "T" and "R" leads from the coin test relays removes any ground which may have caused the (GT) or (SGT) relay to operate, and the operation of (MS1) breaks the locking circuit to (GT). So (GT) and (SGT) release if operated and the release of (GT) takes battery from the windings of (GTT) and (SGA), and they release if operated. The (CTR) relay does not release, however, as it holds through back contact of the (GTT) relay.

The operator requests the deposit of a coin and disconnects, relighting the coin lamp. If a coin is then deposited, a retest is made, and if the coin is deposited satisfactorily the (CTR) relay releases, (CCT) relay operates, all the other coin test relays still operated release, the lamp is extinguished, and the sender proceeds with its functions.

If the lamp is not soon extinguished, the operator will cause the connection to be released by inserting the talking plug momentarily into the priming jack.

COIN FIRST OPERATION

When coin first service is provided, the subscriber cannot start a call without depositing a coin. The tip of these lines is not grounded in the central office when the line is not in use. Consequently, it is necessary for a coin to be deposited to ground the tip of the line; then when the receiver is removed from the switchhook the call is started. With this type of operation, the subscriber sender does not need to test for a coin and the special coin feature is not provided in the sender.

DIAL TONE FIRST AND COIN FIRST OPERATION

Coin service is, therefore, provided as for any other type service except that means must be available for automatically collecting or returning the coin. To collect (or return) the coin it is, therefore, necessary to use a coin district, which requires the assistance of a coin control circuit to collect the coin. Since the coin control circuit is required only a small portion of the conversation time only a few coin control circuits are provided per 100 coin districts. A coin control link and connector circuit is provided per 100 coin districts for connecting these districts to a coin control circuit (maximum 20) when required.

COIN LINES SEGREGATED

To insure that a coin subscriber shall always be connected to a coin district junctor, coin lines must be segregated on separate line link frames which have access only to coin districts. The call is then handled the same as for the non-coin type of service until it is necessary to collect the coin. Flat rate and automatic zone charging service is not provided for coin subscribers. All coin districts are arranged to charge on all calls which reverse the current to the district junctor polarized (CS) relay for over two seconds. On calls through an operator, the collection of the coin is entirely under control of the operator. Since there is no option regarding charging in the coin districts the originating marker always is cross connected as a non-charge condition ("TC" lead from marker to district is, therefore, not required).

COIN CONTROL CIRCUIT CONNECTED

The coin district junctions call in a control circuit whenever it is necessary to collect or return the coin or when overtime operation is provided to test for the presence of a coin before starting a new time interval. The district under these conditions grounds an "ST" lead which causes the coin control link to connect it to an idle coin control circuit in a similar manner to that of the terminating sender link when connecting an idle sender to the calling incoming trunk. During the time that the link connector is setting up the connection (which (SC) relays are operated), an indication is given to the coin control circuit from the district to collect or return the coin as shown on Fig. 2 by operating and locking either the (CC) or (CR) relay,

COLLECTION OF COIN

When the district is connected to the coin control circuit and the link connector is released the (SC) relay is normal and the (B1), (B2), (TR), and (CC) or (CR) relays are operated. Ground is connected to (CN) interrupter, causing the (W) and (Z) relays to function as follows:

	Relays		Relays Operated			Remarks
(CN) int.	(W)	(Z)	OK	Call Failure! **	***	
Closure	(O)	(N)				
Open	(H)	(O)	Z1, CB*, NC Dist SP'			Coin Batt. to line.
Closure	(R)	(H)				
Open	(R)	(R)	Z2	OP,M		Open Coin Batt.
Closure	(O)	(N)				
Open	(H)	(O)	T	LT		Line test for absence of ground
Closure	(R)	(H)				
Open	(R)	(R)	RL	CN, OP,M		Releases Connection

! Failure establishes a connection to an intercept operator for disposition of the trouble.

* If coin is being collected, (CC) relay operated.

** If there is no coin on line (CB), and (NC), relays do not operate.

*** Coin magnet did not function properly to collect or return the coin and remove ground from the line. Coin magnet should operate and hold as long as coin battery is applied to the line. Subscriber is beating by falsely grounding the line to simulate the deposit of coin.

When the call is routed to the operator, indicating a trouble condition, the operator notifies the maintenance force of the condition as indicated by her lamp and holds or releases the line as requested. The operator may release the connection by inserting a plug into the release jack.

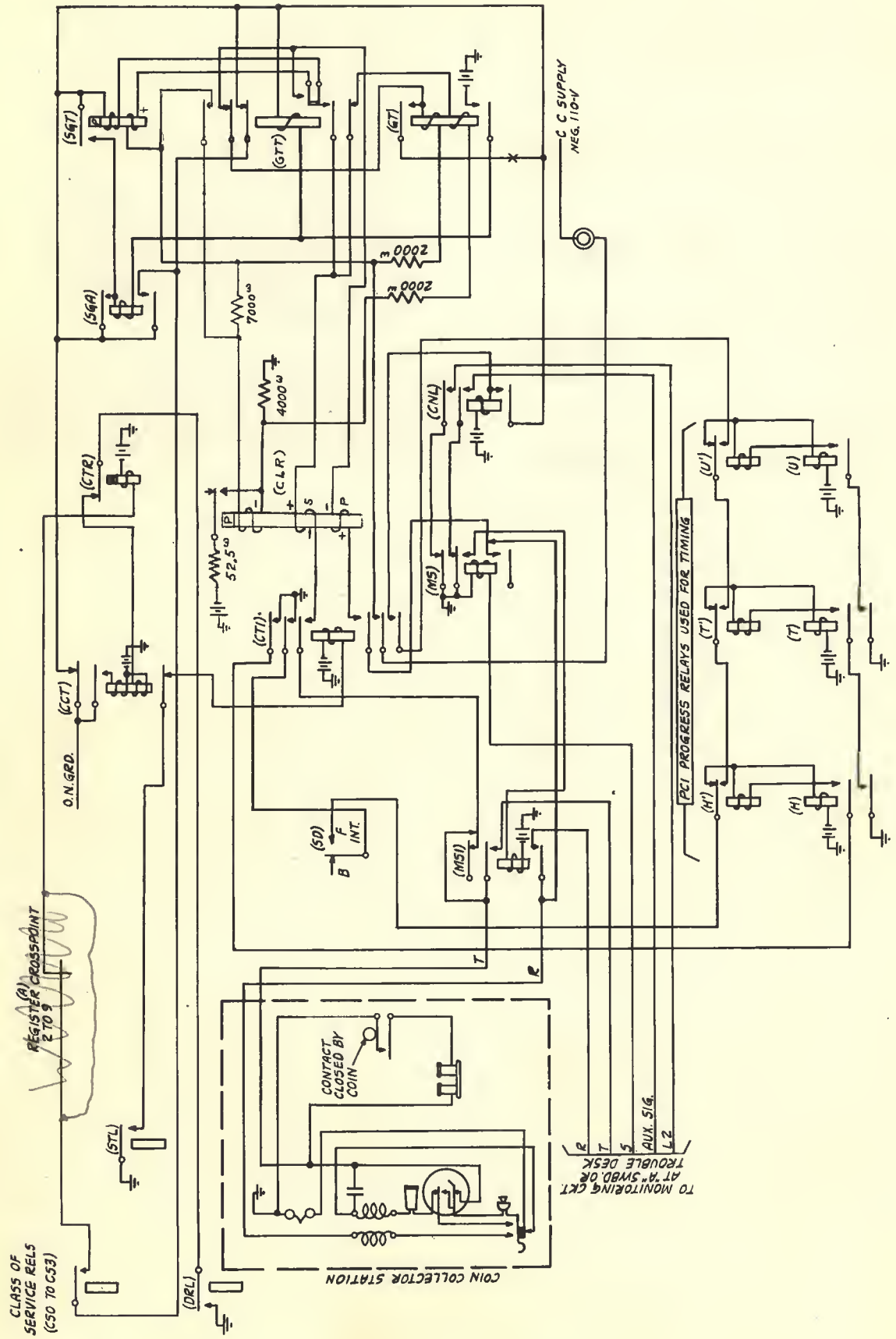


Fig. 1 - Coin Test Crossbar Subscriber Sender

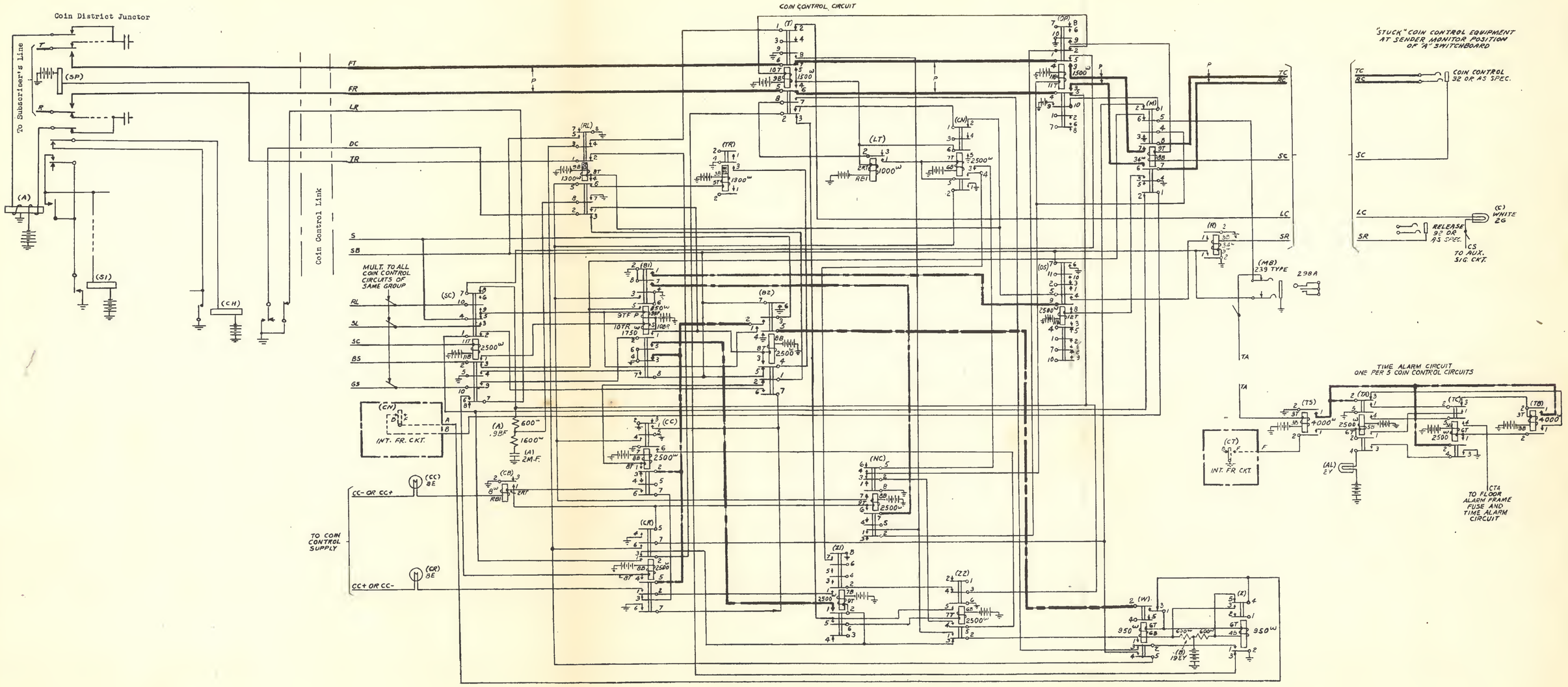


Fig. 2 - Collecting Subscriber's Coin

CHAPTER 29 - KEY PULSING "A" SWITCHBOARD

Assistance calls, some toll calls and intercept calls, are handled by the "A" switchboard. The "A" operator is called by dialing zero for the assistance and toll calls and the intercept calls are routed to the operator due to the subscriber dialing a code or number which is not assigned for use. The "A" operator completes these calls to manual local and tandem offices and to full selector local and tandem offices.

The calls to the full selector offices are keyed up by the operator and, therefore, use a key pulsing sender link for connecting the trunk or junctor to an idle key pulsing "A" sender. The key pulsing "A" district junctor appears along with the subscriber district junctors on the district link primary switches and has access to all the outgoing trunks appearing on the office link and, therefore, requires the use of the originating marker for decoding the code keyed and establishing the connection through the district link and office link as for a regular subscriber call. The key pulsing "A" incoming trunk is used to complete calls in the local crossbar office. Start of ringing and rering is under control of the "A" operator for handling delayed toll calls. The remainder of the calls to full selector office use trunks direct to the office (local or tandem) with an outgoing trunk on each trunk for connecting to key pulsing "A" link and sender circuits.

Calls using trunks direct to a panel 2 wire office center require the use of the originating marker for decoding the code. Calls through panel tandem centers or direct to panel or crossbar offices require the use of the key pulsing sender but do not use the originating marker since decoding or setting of a connection through the district and office link frames is not required.

The types of trunk and junctors used by the "A" operator which require the use of the key pulsing "A" sender are as follows:

Trunk or Junctor	Digits Keyed	Originating Marker	Pulses Sent Out	Terminating Office
KPA Dist.	7	Decodes.	Revertive	Crossbar
		Sets up	Revertive	Panel
		Dist. and	Revertive	2W. Office
		Office Link	PCI	Tandem
			PCI	Manual
OGT to 2WO	7	Decodes only	Same as above	
KPA Inc.	4	Not used	Revertive	Crossbar
OGT Inc.	4	Not used	Revertive	Crossbar Panel
OGT Tan.	7	Not used	PCI	Tandem

The key pulsing "A" sender link functions very much the same as does the terminating sender link; hence will not be described here. The key pulsing "A" sender functions similarly to the subscriber sender except for the keying and recording of the called number described later and that the originating marker is not used on a large number of calls as mentioned previously.

The keying and recording circuit is shown on Fig. 1. As the "A" digit is keyed the (AL) and (AC) relays are operated. The sensitive (TS) and/or (RS) relays is/are operated for every number that is keyed; hence these relays are used to advance the circuit for the registration of the digits on the successive groups of register relays. When a key is depressed as the "A" digits, (TS) and/or (RS) relays operate to operate the (BL) relay, then as the key is released the (TS), (RS) relay releases permitting the (BC) relay to operate. The operation of the (BC) relay releases the (AL) and (AC) relays, thus preparing the register circuit for recording the "B" digit. This type of operation is repeated until all the digits are recorded.

The numericals are transmitted over the "T" and "R" leads in the form of high or low pulses which are either positive or negative. The marginal (TM) relay operates on a heavy pulse either positive or negative on the "T" lead. The contact of this relay is extended through the (-C) relay contact to operate the (-1) register relay which locks to record the number keyed. Similarly the (RM) marginal relay responds to heavy pulses on the "R" lead which in turn operates the (-5) register relay. The (TP) and (RP) relays operate on negative pulses on the tip and ring leads and in turn operate the (-2) and (-4) register relays respectively. A negative pulse has 48 volt battery in the keyset circuit and 24 volt battery in the sender circuit. The pulses transmitted and the register relay operated for each number are shown on Fig. 1. L+ means a light positive pulse while H- indicates a heavy negative pulse.

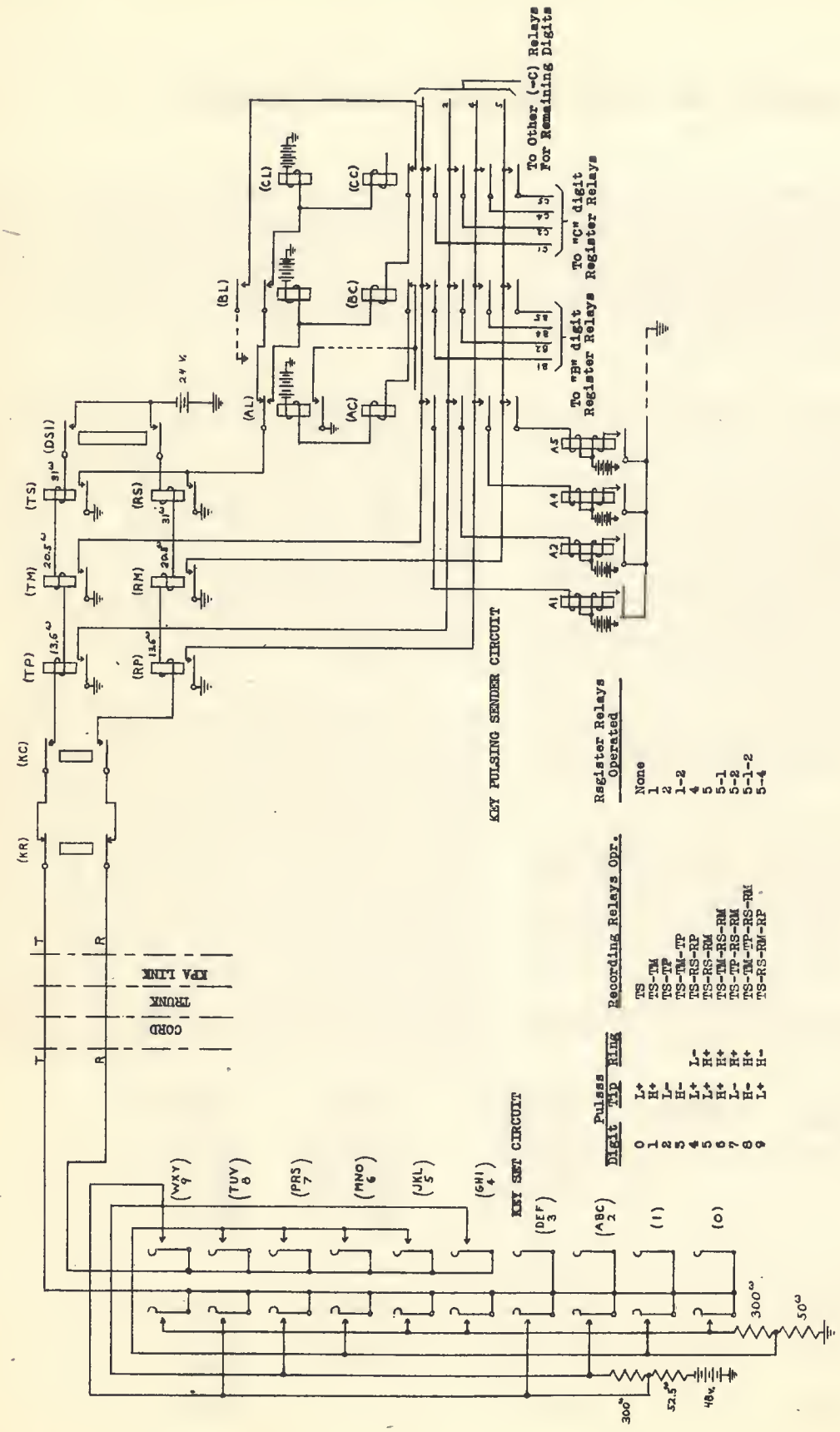


Fig. 1 - Key Pulsing "A" Switchboard - Keying and Register Circuit

CHAPTER 30 - CALL DISTRIBUTING "B" SWITCHBOARD

Calls coming from a manual office, either local or toll, to a crossbar dial office are completed through the call distributing "B" switchboard. These calls are made over incoming trunks which are mounted on the same frame as the full selector incoming and which are similar to the full selector incoming except for the type of supervision. The incomings from toll offices are equipped with a higher grade of transmission than are the local incomings, and are also arranged for the toll operator to start ringing or rering the called subscriber.

When the operator in the manual office plugs into a trunk to a crossbar office, the trunk supervisory relay operates, causing the terminating sender link to seize an idle call distributing "B" sender. The sender then connects the call through to a "B" operator who receives the call from the "A" operator. The "B" operator writes the call on a ten button keyset, one operation for each digit. The key at this time is connected to register relays in the sender for recording the number, as will be described later. With the called number recorded in the "B" sender, the "B" operator is dismissed from this call and the "B" sender with the assistance of the terminating marker connects the incoming through to the called subscriber in a manner similar to that previously described when a full selector incoming and terminating sender were used.

The keying and recording circuit is shown on Fig. 1. This is a 3 wire circuit for transmitting the information from the keyset to the "B" sender. The pulses over the three leads and the register relays that are operated for the various numbers are shown on the chart on Fig. 1. The sensitive (-1) and the marginal (-4) register relays operate over either the "K1" or "K2" leads, through a (K1) or (K2) relay winding and one winding of the (K3) relay and are locked over a second winding. The (-2) register relay operates under control of the (K2) relay which is a sensitive relay operating on either a light or heavy pulse on lead "K2". The (-3) register relay is a marginal relay whose winding is in series with one winding of the (K3) relay on the "K3" lead and which operates only on heavy pulses.

The (TR1), (TRA), (TR2), (TRB), (TR3), (TRC), and (TRD) relays are all operated soon after the sender is seized and before keying. This closes the lead through to the (TH-) register relays. As the numerical key for the first digit is depressed the (K3) relay operates releasing the (TRA) relay, then as the key is released the (K3) relay releases in turn releasing the (TR1) relay. With the (TRA) and (TR1) relays normal the circuit is ready to receive the hundreds digit. The (TRB) and (TR2) relays are released when the hundreds digit is keyed. The (TRD) relay releases when the units digit is keyed.

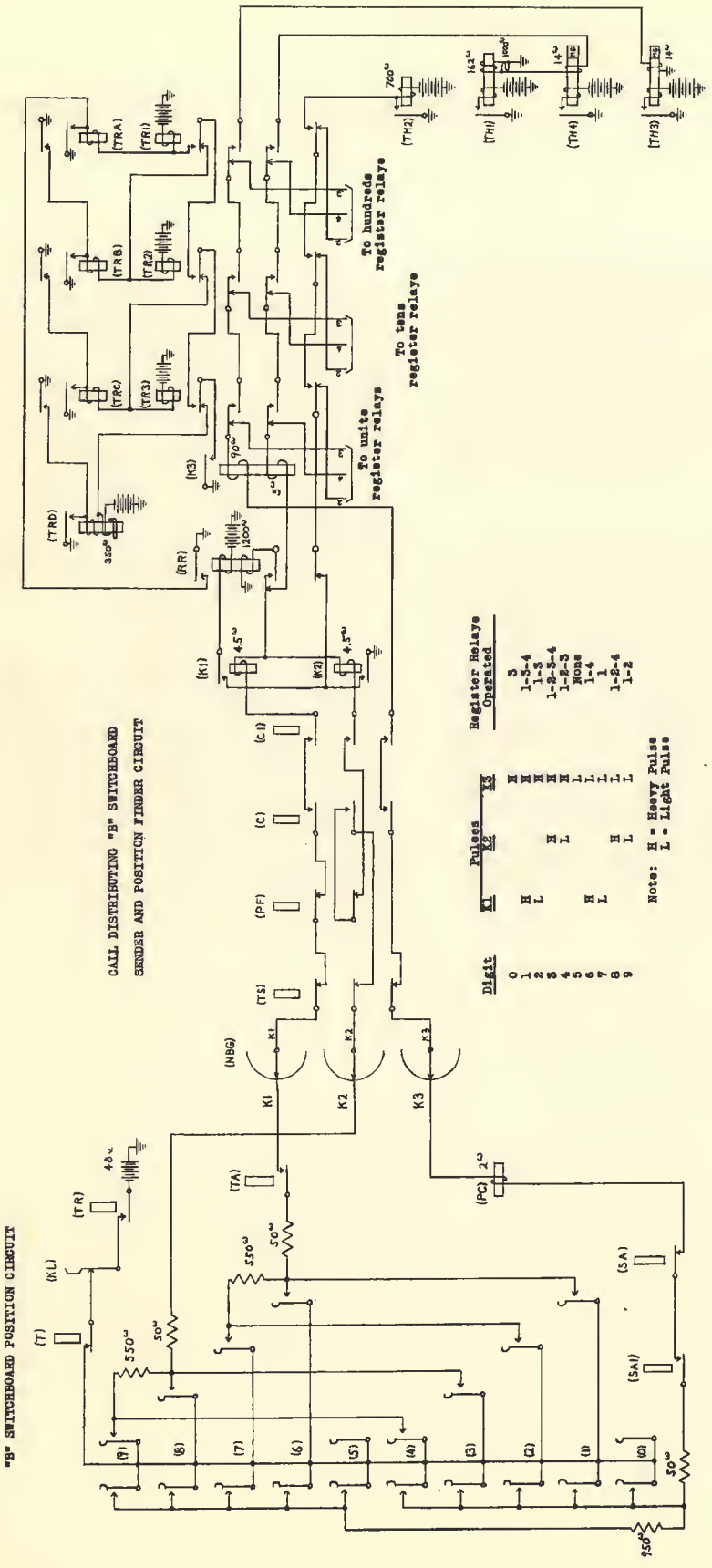


Fig. 1 - Call Distributing "B" Switchboard - Keying and Register Circuit